The MINING CONGRESS JOURNAL

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In This Issue

Contributors:

H. J. Bryson, F. C. Gilbert, J. E. Borland, David Stoetzel, G. B. Southward, E. J. Christy, E. W. Lamb, L. B. Abbott, William P. Young, Roy Adams, Edward Bottomley, J. E. Edgeworth, V. C. Robbins, Franklin Bache.

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The MINING CONGRESS JOURNAL

VOLUME 15 AUGUST, 1929 No. 8

Contents

EDITORIALS

FEATURE ARTICLES

DEPARTMENTS

Practical Operating Men's Department

METAL

Application of Electrical Equipment to Mine Hoists
Shovel Control

COAL

Various Mining Systems with Mechanized Loading

Applications of Long Face Mining with Mechanized Loading

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E. R. COOMBES, *Editor*

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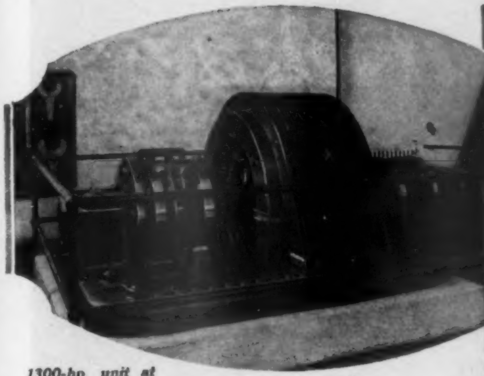
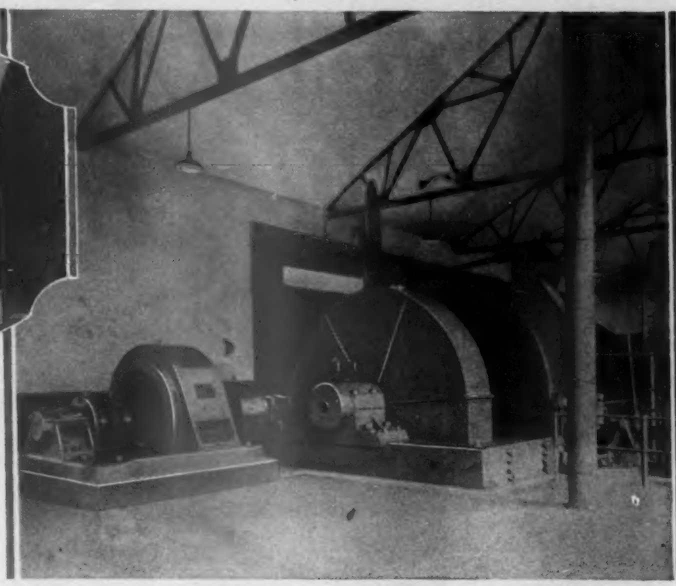


1300-hp unit at the Pioneer Mine



1500-hp., 360-r.p.m., 2200-volt, 3-phase, 60-cycle G-E induction motor operating shaft hoist in Geneva Mine, Oliver Mining Co., Ironwood, Mich.

The MINING CONGRESS JOURNAL

**A Monthly Magazine—The Spokesman For The Mining Industry—
Published By The American Mining Congress**

VOLUME 15 AUGUST, 1929 No. 8

Editorials

A New Public Land Policy

NO announcement has been made during recent years fraught with so much of benefit to the West as the recent address of Dr. Ray Lyman Wilbur, Secretary of the Interior, before the Governors Conference at Boise, Idaho, July 9th. No question is more vital to the West than that which relates to the control of its Public Lands. For many years these lands were administered by the Federal Government upon the theory that they were held by it as a trustee for the benefit of the states in which the lands were located.

Under that policy the West prospered more rapidly than the East and in fact its production of minerals largely assisted the progress of the East. For a time there was a careless use and a resulting waste of the forests which had it been continued would in the end create conditions similar to those which prevail in the wastes of China and the Far East.

There was a real necessity to protect the forests of the West and out of that issue grew the forest policy of the Federal Government. The benefits derived from a better care of our forests justifies the creation of the forest reserves and the original policy designed for their administration.

Then the political reformer appeared and the danger of a monopoly in public land ownership was used as an excuse for the withdrawal of the mineral deposits and the water powers of the West from location and entry, and it was decided that these lands should be held and administered by the Federal Government at Washington as a measure of conservation. These withdrawals took from the enterprising pioneer the incentives which justified the hardships which must be undergone in the development of natural resources.

All of this was done in the name of conservation which had its culmination in the leasing law. Immediately the development of the West was retarded. It remained for the present administration to realize the danger of this situation. Secretary Wilbur, at the recent Governors meeting after discussing the basic importance of protecting our water supplies used the following language with reference to the Public Lands.

"It seems to me that it is time for a new public land policy which will include transferring to those states willing to accept the responsibility the control of the surface rights of all public lands not included in national parks or monuments or in the national forests. With sound state policies based on factual thinking it may eventually develop that it is wiser for the states to control even the present national forests. Such a policy will need to be worked out so as to hold the oil, coal and mineral rights of public lands subject to some form of proper Federal prospecting law with development on a royalty basis of discoveries, and with due consideration to conservation for the future. The policy of transferring Federal lands for school purposes is well established and could be further initiated wherever state laws and state policy warrant the transfer.

"The states of the West are water conscious and they can more readily build up those wise water conservation measures upon which their very life depends than can the distant Washington Government. It would be fair too for the citizens of Western states to have the privileges already in the possession of those of the East.

"Responsibility makes for real statehood just as it makes for manhood. The Western states are man grown and capable of showing it.

"The National Government can still be helpful in building dams, in protecting navigable streams and in assisting with state compacts, but it should withdraw from the details of management of community enterprises properly subject to state laws.

"You men representative of the Western states could well prepare your state governments by proper park, grazing, lumbering and water conservation laws for the reception of the new responsibility of the public domain. I feel that in the long run you can be more safely trusted to administer that heritage wisely than it can be done from offices in the national capital.

"It will require trained vision and forward thinking if the semi-arid West is to conserve its own future."

Dr. Wilbur's recommendation applies to the surface rights only, but the reasons given by him for this advance proclamation apply with equal force to the control of the valuable mineral and power resources of the West. The separation of the surface from the subsurface almost surely tends toward litigation and to quote Dr. Wilbur, "Responsibility makes for real statehood just as it makes for manhood. The Western states are man-grown and capable of showing it."

The reasons for retaining the mineral lands by the central government have been based upon the national desire for conservation of mineral resources. Conservation is perhaps best defined as a plan to bring about the greatest practical use and the least waste of our natural resources. Conservation, however, has nothing to do with ownership. Conservation is the prevention of waste. Much greater waste may be expected from the tenant than from the owner. Few men are as careful of the property of others as of their own property and this is particularly true with reference to public property. It is hard to conceive the owner of a property who is not desirous of preserving that property and applying it to the best known use. The reason then for withholding the mineral rights from the proposed transfer to the states must be based upon some other theory than conservation. The interest of the nation at large is always served by the greatest prosperity in each of its units. The prosperity of the west would be vastly increased if the development of its mineral resources could be relieved of the management of theoretical men; the states would be benefited by having this property subject to the taxing power through which public roads and public schools

could receive the benefit. It is an unconscionable thing for the Federal government to make money out of the heritage of the West. The Federal government will be expected in making such transfer to do so under such restrictions as will protect the several states and at the same time to encourage development and add to state incomes through the power to tax not only the lands transferred but the improvements which private ownership will assure.

It is up to the West to break from the condition of restriction under which its public aspirations have been subdued and to rise to the occasion now afforded to show its ability to properly administer its own property in such a way as to prevent waste and to bring about a renewal of that development which for so many years was carried on with marvelous success.

Coal Stabilization

THE biggest and the most important problem facing the American people is the stabilization of the bituminous coal industry. It is not a new problem. For more than twenty years it has been increasingly difficult to operate a coal mine with profit.

The average annual failures of coal companies during that period has been greater than the total of bituminous coal operators who have become wealthy from coal production. The public mind is possessed with a notion that coal production has been very profitable and that coal barons, men of fabulous wealth and without conscience, are charging them exorbitant prices for a necessity. The coal baron is almost a myth. Out of the 13,000 possible producing units, out of the 6,000 or 7,000 mines which are equipped with operating plants, we venture the assertion that not 500 have made any profit since 1922.

There have been a number of fortunes made by speculators in coal lands. There have been a considerable number of fortunes made by speculators in coal. But the number of great fortunes made in the production of coal is so small as to be disgraceful. The coal baron does not exist.

The coal industry should be among the most profitable of industries.

It deals with a necessity. It has a certain market for more than 450,000,000 tons of coal annually. It should make a fair profit on every ton of coal taken from the ground. Every ton of coal mined leaves the mine with one less ton of coal in reserve. Coal production is a wasting industry.

The coal industry is and has been making marvelous advancement in production methods. Every visitor to the recent coal machinery exposition at Cincinnati was impressed with the vast improvements made in coal mining and loading machines, in coal cleaning devices, in hoisting and handling machinery. No other industry, except the aircraft and radio industries, has made so great an advancement in production methods and machinery as has the coal industry and yet every development but adds to the surplus coal production capacity, which is the curse of the business.

Each operation is striving by improved methods and larger operations to so lower his production costs as to enable him to undersell his competitor and drive him out of business. And his competitor is doing the selfsame thing.

And thus the merry war goes on while the Government provides the farmers with a half billion fund with which to stabilize output to markets or markets to output and the oil industry with governmental approval and help is seeking methods by which its output can be controlled.

The "Philosopher" Dreams Of Mining

THE July issue of a current magazine contains an article by a well-known writer and self-styled "philosopher," describing his trip through a mine. He details his outfitting with cap, lamp and boots; his 1,600-foot drop down the shaft; and then continues:

"Long tunnels, dimly lighted, paved with mud and splashing planks; underground rivers, roaring and whirling at our feet; and crowding us against wet walls; great beams at every yard, propping up a thousand tons of earth and metal over our heads; protecting the passage from a fault; and there at last, at the tunnel's end, a group of men digging out ore.

"Old men, middle-aged men, young men, and yet all of them old, cheerless, and silent; not a word from any of them as they work; only the click of the pick, the crunch of the hammer, the long scratching of the shovel, the weird throb of the drill.

"Big hands of a color with the earth, grim faces bespattered with black mud, cheeks pale with the dripping, sunless air; eyes as pale and silent as their tongues; minds resentful of pity, remembering the fate of entrapped friends, and counting long hours and petty gains; men de-animate and unsouled, outcast from the sun for uncommitted crimes, condemned to Hell before their death.

"I'd rather be a medieval serf under a murderous Czar, and take my chance with death in the sun, than live half the hours of half my days in these guts of the earth!"

Bravo! say we. Any man with his gift of imagination should be a portrait painter, or a writer of bedtime stories.

We are well aware that certain anthracite collieries pump 16 tons of water for every ton of coal removed, but we have yet to traverse a mine entry where "underground rivers roar and whirl at our feet."

The "philosopher" remarks the grimy hands and faces of the workmen; we wonder whether he would recommend cotton or leather gloves; and whether an underground barber shop would cause their "sunless eyes" to light, and their "silent, de-animate and unsouled" faces to radiate?

He comments on the silence of the workmen, and we again wonder whether this gifted writer considers horseplay and tomfoolery compatible with serious-minded effort to give an honest day's work for an honest day's pay?

It is in such veritable piffle as the quotation above that sycophant sob-sisters and puerile pen-pushers delight to delve.

It has long been known to those familiar with the mining industry that, given free choice, the average miner prefers to work underground, where unvarying temperature, freedom from rain, snow and sun; good ventilation, and regularity of working conditions all make for physical comfort.

In fact, it is well known that unemployed miners, due to shutdown of mines, who have been offered pick and shovel work on roads and public works at better pay, have invariably refused to work in the outdoors; and, regardless of the overmanning of the mining industry, miners from all parts of the world, in all classes of mines, continue to refuse any other occupation.

The general rules of mine ventilation provide that each miner shall have at the working-face 100 cubic feet of air per minute. Many large coal mines exhaust more tons of air per day than they extract tons of coal.

Nor, under the present 8-hour day, does any miner live "half the hours of half of his days" underground.

A little less imaginative writing, Mr. "Philosopher," and a little more attention to social and economic conditions.

Pressure From Wall Street

PROFESSOR WILLIAM A. ORTEN, head of the Division of Economics, Smith College, Northampton, Mass., is conducting a summer school of economics at the University of California. On his way west Professor Orten stopped in Denver to give a lecture on international relations, under the auspices of the Foundation for the Development of Social Science of the Denver University. Professor Orten is somewhat exercised because of his fear that European countries will not be able to meet their financial obligations to the United States, "unless they be given a fair chance to trade in this country." "I believe," Professor Orten says, "that the remedy will come from pressure from Wall Street bankers who can foresee danger to their many loans amounting to many billions of dollars in the event Europe can not sell her goods in the United States by reason of high tariff laws."

This is neither a new argument nor a sound argument. Examination of our commerce with foreign countries indicates that notwithstanding a protective tariff nearly all foreign countries have gradually increased their trade with the United States. At the same time by preserving to our industries a good part of our home market through a protective tariff, mass production has been made possible. Through mass production costs have been decreased and the luxuries as well as the necessities of life have been made available to practically all of our people. This condition has been based upon a high wage scale, and the resultant high purchasing power of our wage earners, which permits them to use 90 percent of our own manufactured products and to take and pay for importations almost equal in amount to the 10 percent of manufactures which are exported. It is not logical to expect our wage earners to purchase more of foreign goods except by the process of shutting off home production and again lowering the amount of wage money available for the purchase of goods of any kind. It is vastly more important to keep our own industries in full operation, to keep our wage earners fully employed, than it is that we shall collect the obligations due us from foreign countries.

The opponents of protection insist that the tariff is a tax; that the tariff duty is added to the price and that the consumer pays the cost of production plus the amount of the tariff duty paid. We do not subscribe to this theory, but if it is true then the tariff is in no sense a bar to imports. Let us assume that the duty on steel rails is $5 per ton and the cost of production abroad is $35 per ton and the domestic cost $40 per ton, the importer can pay the $5 duty and still sell his rails at the price which the domestic producer must charge if he is to break even. If the market price breaks to $35 per ton without the tariff, then the importer would get for his rails the same $35 net that he would get if he sold at $40 and paid $5 to the Federal Government in duty. The net result to the foreign manufacturer is the same. The great advantage to the importer of a no tariff policy is that without it he would control the whole market instead of being obliged to fight for a small corner.

Without a tariff the domestic producer would go out of business unless he could, in some way, reduce his cost of production to the cost level of his foreign competitor. To do this he must reduce the wages paid to the level of the foreign wage. Whenever the foreign wage levels are raised to a parity with our own we shall need no protective tariff. In the meantime the importer pays in tariff duties the amount he saves in wages and gets into our markets on a fairly competitive basis. The reports of the Department of Commerce prove conclusively that foreign nations can pay their debts to us from the sale of goods in our markets.

If Professor Orten knew his economics better, he would know this, and if he knew his politics better he would know that the surest way to defeat a bill in Congress is to make it appear that Wall Street influences are fighting for its enactment.

Retaliatory Tariffs

A VAST number of protests have been received from foreign countries with relation to the proposed tariff bill now being considered by the Senate Finance Committee. It would seem that these countries have changed, what has been regarded as the uniform principle in international affairs as applied to the right of every country to impose whatever tariff restrictions might seem best adapted to develop its own industrial life. Some twenty-eight countries have communicated with the Congress of the United States questioning our tariff policy as embodied in the bill passed by the House and now under consideration by the Senate. The right of all countries to regulate their own internal affairs has ever been recognized. The very principle of tariffs recognizes this right, but for some apparently newly developed reason a number of foreign countries seem to feel that they should be consulted as to the laws made by our Congress.

There is much talk in the foreign papers to the effect that foreign nations may combine in a tariff war against the United States and this bluster is fortified by frequent statements in this country to the effect that the House bill has so increased tariff rates as to make it an unconscionable measure.

There is an old saying, "Give a dog a bad name and hang him." This applies with special force to the effort to discredit the tariff bill now under consideration by the Senate. The cry "Robber Tariff" is not new. It was applied without effect to the Payne-Aldrich bill, under which our country made such wonderful industrial development. It was applied without effect to the Tariff Act of 1922, under which the United States has been able to pay a billion dollars annually upon its public debt notwithstanding two substantial reductions in its tax rate and the industrial progress of the country has been steadily upward. The present bill is being subjected to the same criticism by those who express great concern for the farmer.

It will be noted that the greater part of the increases under consideration are for the benefit of the farmer and those who criticise the measure most insist that the farmer's interest is not being considered.

The one item most severely attacked is the Sugar Schedule. Farm aid in every other line must come by getting rid of the surplus, but in sugar there is no surplus. Our consumption is much in excess of our production. Our sugar cane and sugar beet lands can be made to supply our entire requirements. The arid states of the West have millions of acres able to produce beets with a sugar content of from 15 to 23 percent, but the costs of production are much higher than cane sugar in Cuba and the Philippines.

Shall we force these lands into the production of wheat and potatoes to be thrown upon an already oversupplied market in order to save the sugar consumer a per capita cost of 32 cents? Or shall we use our sugar lands for sugar and the lands which can not produce

sugar for raising wheat and potatoes? By the latter process all will have a profitable market; by the first process the American farmer will need still more Farm Boards and still more half billion dollar appropriations. And this is where the mining industry comes in.

It can only prosper when prosperity is general and where its sister industries are operating at a high rate and with fair profits. It must pay its share of the increased taxation to support this aid to the farming industry. This will be done cheerfully, but only on condition that the more modest requests of the mining industry shall receive proper consideration, and that the threats of retaliatory tariffs by foreign countries shall be ignored. When these countries concede us the right to direct their legislative bodies it will be time to consider their suggestions and not before.

Labor Disputes In Illinois

WHILE the bituminous coal industry as a whole has been suffering for many years, that industry in the states of Illinois and Indiana has been in worse condition than any of the other states, these being the two states which have retained the non-union basis of employment. The severe competition covering the industry made it more difficult for these states to operate on the non-union wage scale basis, while most of their competitors were free to bargain with the miners upon a basis which would permit the sale of the output. Conditions seemed hopeless in these states and the operators in other states were inclined to believe that these states had been removed as a source of competition. But a new leader has risen in Illinois.

After many months of negotiation the coal operators of Illinois have elevated Joseph D. Zook to a position of leadership and negotiations have led to his appointment to represent the operators while the United Mine Workers have named their president, Harry Fishwick, and William B. Wilson, ex-Congressman and first secretary of the Department of Labor, has been selected as the arbitrator to determine any controversies between the two contending factions over wages and operating conditions. This is a hopeful experiment.

Mr. Wilson has a long and creditable background of public service through all of which he has maintained a reputation for integrity and fairness as well as courage in the expression of his conviction. Mr. Wilson was one of the organizers of the United Mine Workers of America. Many people have feared that his background of experience and union sympathy would color his decisions. This experiment would have been more hopeful if the arbitrator had been a man with no past connection with either side of the controversy, but it is hoped that the background will be ignored and that Mr. Wilson as such arbitrator will effectively exemplify the honorable reputation which he has well earned through a long experience in public service.

Industrial Research in Mining

IMPROVEMENT and progress in the development and expansion of any industry, the discovery and utilization of new methods and processes, recovery and utilization of wealth contained in the soil, all are dependent upon research. Research in industry is an established branch of every industrial activity. Both in the production of raw materials and in their fabrication, the results of research play an important part in the success of the enterprise.

Research, according to the new standard dictionary, is: "Diligent protracted investigation, especially for the purpose of adding to the human knowledge; studious inquiry."

In the metal mining industry, research has made possible the development of methods and processes by which low grade ores, once passed over by the prospector and miner as worthless rock, can be recovered economically. The tremendous reserves of minerals thus made recoverable have added enormous values to the economic wealth of the nation.

In the coal mining industry research work has had to do more with methods and processes of mining by which costs of production could be reduced and waste avoided. This has involved not only improvements in methods of mining, but improvements in the mechanical devices and equipment necessary to low-cost mining and handling.

Research work means, figuratively speaking, going behind the scenes and bringing to light facts for the benefit of industry at large concerning methods of operation, processes used in production, and measures or policies adopted to insure the highest efficiency in a particular operation or enterprise.

The Mechanization Division of the American Mining Congress is doing just this thing for the coal industry. This division has conducted a systematic, well-planned, well-directed and continuous research into all phases of coal mining operations. The results of the studies and investigations are being carried monthly to the coal mining industry through the columns of this Journal. The tremendous importance of this work is being recognized by the coal operators as well as by the manufacturers of coal mining machinery and equipment.

A Theoretical Speculation In Gold

THE purchasing power of gold is less than at any time during recent years. The gold reserves of the world are therefore seemingly of less value than ever before. The wealth and property of the world are greater than ever before and yet if all the gold in the world were in the hands of Shylock, he would be able to purchase all the goods in the world and have much of his gold remaining. The duty put on gold is increasing while its value is decreasing. A most anomalous situation.

The production and industrial power of the world has enormously increased through the use of machinery. It may well be said that the service of gold has increased even more rapidly than the service of mechanical agencies. Not so many years ago gold and silver were money. Paper money was based upon metallic reserves and there was but little of our circulating medium which was not based either upon a metallic reserve or upon a Government bond which was the basis of issue of bank notes by the national bankers. Until the creation of the Federal Reserve banking system financial panics were of almost regular occurrence and whenever the public mind was distrustful bank runs ensued and the scattered location of the money of the country was such as to make difficult, if not impossible, the protection of banks against the public demand to turn a bank deposit into cash in hand.

At the beginning of the World War the United States held approximately one-third of the gold reserves of the world. On account of war conditions our gold reserves were very largely increased. With these increases credit gradually expanded until in 1920 there were more than $14 of bank credit to $1 of gold. At the present time

this credit expansion has been reduced and there is a gradual tendency at this time to deflate credits. Gold production in the United States has been steadily decreasing since 1915. Production of gold in the world decreased very rapidly from 1915-1922, and since that date has been slowly increasing. At the same time the industrial uses for gold have increased so rapidly that it is quite probable that the total gold reserves of the world are considerably less now than in 1915. Bank credits and money in circulation have increased enormously. In practically all of the progressive countries of the world gold is the basis of money, but the credit based on gold has been multiplied many times. In the United States gold production, except in mines where it comes as a by-product, is practically discontinued. Were it not for the by-product gold our annual national production of gold would only be approximately 25 percent of what it was in 1915. The fact that gold has increased in the service which it renders while its value has actually decreased has resulted in burdens which prevent gold production upon a profitable basis.

Some day there will be a change. Some plan will be devised by which gold production may be increased. A contracting gold supply and an increasing use for gold can not go on forever. The governments of the world must have gold enough to maintain stable currencies. An industrial panic which would break down price levels would bring about an increased gold production. A governmental bounty of the difference between the price levels of 1913 and the present would restore the gold industry to normal conditions.

The governments can mine gold on their own account. At the present price level in the United States the cost of gold production is approximately $30 per ounce. A bounty of $10 per ounce would bring a return to the average production of 1913. If the Government were to operate on its own, the cost would more likely be above $40 per ounce.

None of these things are likely in the near future. We are getting our gold needs from the share of foreign countries in the world gold supply. But our gold mines are suffering—a victim of circumstances.

Standardization By Cooperation

APPEARING in this issue is an announcement of the cooperative relations established between the American Standards Association and the Department of Commerce, Bureau of Standards. The agreement, which is reproduced with this announcement, is one of far-reaching importance to the mining industry; it will do much to correct misapprehension as to the status of the American Standards Association and the relation of the Bureau of Standards to industrial standardization.

This jointly signed agreement states that the Bureau of Standards, through its Division of Trade Standards, will act as a centralizing agency for industrial and commercial groups, requesting its cooperation in the adjustment, application and promotion of standards that will facilitate production and marketing of the commodities which concern the requesting group; that primarily the effort of the Bureau is to serve those groups which have no satisfactory standardization facilities.

THE MINING CONGRESS JOURNAL has long maintained the position that industrial standardization should be established by industry itself without the interference of government. The fact that industry is ready and willing to undertake necessary standardization and simplification is evidenced by the strong organization it has created for itself.

The Board of Directors of the American Standards Association, consisting of Quincy Bent, vice president of the Bethlehem Steel Company, representing the American Society for Testing Materials; Dr. George Kimball Burgess, Director of the Bureau of Standards, representing the Department of Commerce; Cloyd M. Chapman, consulting engineer, vice president of the American Standards Association; Clarence L. Collens, president of the Reliance Electric Company, representing the National Electrical Manufacturers' Association; Howard Coonley, president of the Walworth Manufacturing Company, representing the American Society of Mechanical Engineers; L. A. Downs, president of the Illinois Central Railroad, representing the American Railway Association; Bancroft Gherardi, vice president and chief engineer of the American Telegraph and Telephone Company, representing the American Institute of Electrical Engineers; F. E. Moskovics, president of the Improved Products Company, representing the Society of Automotive Engineers; Wm. J. Serrill, chairman of the Research Committee of the United Gas Improvement Company, president of the American Standards Association and representing the American Gas Association; C. E. Skinner, Assistant Director of Engineering of the Westinghouse Electric and Manufacturing Company; Matthew S. Sloan, president of the New York Edison Company and National Electric Light Association, representing the Electric Light and Power Group, and Robert J. Sullivan, vice president of the Travelers' Indemnity Company and also the Travelers' Insurance Company, representing the American Standards Association safety group, comprise a directorate of outstanding individual capabilities and great industrial significance.

The development of mining standards by the American Mining Congress, member body of the American Standards Association, and their ultimate acceptance by that association as American Standards, Tentative American Standards, or American Recommended Practices, will do much to assist an industry which is overburdened with odd sizes, shapes and designs of equipment and varieties of ways of performing numerous typical mining operations.

Mergers

THIS is an era of industrial consolidations. Manufacturing enterprises and industrial enterprises of all kinds have been and are being consolidated into large units, the better to reduce costs, secure the greatest advantages from mass production, and develop the highest efficiency in the services of distribution and maintenance. Consolidations in industry have not tended to stifle competition and create monopolies such as resulted from mergers prior to the enactment of the Anti-trust Laws. If anything, competition is keener. Each industrial unit is striving to give to the consuming public a superior product at a minimum price. The public therefore is benefiting from this trend in all branches of American industries toward consolidations. The public no longer can be aroused to a fear of mergers, because these are now an accepted and recognized part of the economic machinery of the country, which is necessary to high wages and standards of living, mass production and steady employment, and individual and general prosperity.

The Mineral Industry in North Carolina

New processes and new plants bring several millions investment — Gold continuously produced for 130 years — Copper mining active — High-grade magnetite in Western North Carolina—State leads in production of residual kaolin—Many new non-metallic plants in operation.

By H. J. BRYSON *

IN the year 1928, the mining and quarrying industries in North Carolina continued in the same prosperous and substantial condition as in the year 1927. Several new plants have been constructed and many old plants rebuilt during the past year. There has probably been as much money invested in new plants during that period as has been in any like period in the history of the state. In many of the mineral industries new processes have been introduced which have brought about changes for the better in the finished products. As a result of these changes, a much higher grade material is being produced. Especially is this true in the kaolin clay, feldspar and mica industries.

During the past year, or at the most 18 months, 11 new mineral plants have been completed or are under construction. Four other large plants are at the present time under consideration. The total capital invested when the plants are completed will reach several million dollars. Such an investment of capital, in so short a time, shows that the mining companies have faith and confidence in the mineral resources of the state.

METALLIC ORES

Gold and Silver

During the past year the gold and silver produced came principally as a by-product from the copper mine in Swain County. However, recently a great deal of interest has been shown in the old gold mines of the state. The mines attracting the greatest interest at the present time are located in Davidson, Franklin, Nash and Union Counties.

At the close of 1927 the total output of gold in North Carolina was $23,661,400. Every year since 1799, the year in which a 17-pound nugget was found and which was the first authentic record of the discovery of gold in this state, gold and silver in varying amounts have been produced. There are 331 old mines which have shown a gold production in North Carolina. However, during the past few years only a small amount has been recorded which came principally as a by-product from the copper mines.

In 1927 four companies reported a production of gold. The chief prospecting in 1928 was done at the Howie mine by the Jackson Gold Mining Company. Mr. L. Barnett Newby, general manager of the company, reports that the investigations so far have been very gratifying. All of the surface equipment at the mines has been repaired and painted and pumps have been installed which are unwatering the main shaft at the rate of 300 gallons per minute. In Halifax County the Argo property has been taken over by a Philadelphia company which has installed a 200-ton plant. From information received the results have proven very satisfactory. In the same locality two other companies have taken over properties which are now being prospected thoroughly.

Copper

The date of the discovery in North Carolina is not known but it is probable that it was recognized very soon after the first gold mine was opened in 1799. The first record of production was in 1852 from the Stith mine in Guilford County. Since that time the records show a production of 12,081,168 pounds of copper valued at $1,778,380. The production in 1927 was 5,443,115 pounds and the estimated production in 1928 is a great deal more.

The interest in copper at the present time is confined chiefly to the copper belt of Swain County, from which the production of 1927 came. However, some prospecting has been done in Haywood, Jackson, Ashe, Davidson and Person within the past few months. With the price of copper soaring around 18 cents per pound it is probable that some of the old mines will be reopened in the near future. There are 66 old mines in the state which have shown a production of copper.

Iron

Iron ore was first produced in North Carolina in 1729, when small shipments of ore were made to England. The ore first produced came principally from the coastal plain bog iron deposits. The industry spread westward until today the only ore produced comes from the extreme western part of the state, chiefly from Avery County. However, in the past few years a great deal of iron ore has been shipped from Cherokee County. A few years ago the former state geologist, J. H. Pratt, made an estimate of the iron ore reserves in this state. Below is the estimate of the future supply of ore which can be worked when the price of iron and other conditions are such as to warrant it. An arbitrary depth of 100 ft. was taken.

Magnetite	8,975,000 tons
Tintanic Magnetite	1,300,000 tons
Hematite	900,000 tons
Limonite	5,000,000 tons

A great deal of interest has been shown recently in the magnetite ores of Avery and Mitchell Counties. This interest is due to the high grade magnetite ore found. It is said that this ore makes a high grade steel unequalled in the United States.

Lead-Zinc

A very important discovery of lead-zinc ore was made recently in Haywood County near Crabtree. At a depth of 33 ft. the vein showed a with of 71 in. Analyses made by Penniman and Brown showed 34 percent lead, 17 percent zinc and 6.5 percent copper. Core drilling is to be done in the near future and if the deposit proves to be extensive the property will be developed.

NON-METALLIC ORES

Asbestos

Considerable activity has been shown relative to the amphibole (anthophyllite) asbestos which occurs in Avery and Macon Counties. Two plants have been

* State Geologist of North Carolina.

built which will produce from 50 to 60 tons per day. One other property in Yancy County has been purchased by a Chicago company which intends to erect a plant at an early date.

Kaolin

North Carolina leads in the production of residual kaolin clay. These deposits occur chiefly in Mitchell, Yancey, Macon and Jackson Counties. A new process of washing the clays was introduced in 1927 by the Norman G. Smith Company, of Spruce Pine. A large Dorr-bowl classifier takes the place of the old-type settling troughs. It is said that the clay produced by this method is far superior to that produced by the old method. Also this same company worked out a new process for the recovery of scrap mica from the clays. From 3 to 5 tons of mica are recovered daily at a cost which is a great deal less than the cost of grinding the scrap mica.

Feldspar

The main feldspar producing area of North Carolina is the Spruce Pine District. In the past two years the grinding capacity of the feldspar mills has been increased from 180 tons daily to 410 tons. Four plants are now in operation with the fifth proposed for the early part of 1929. The production in 1928 is estimated at 70 percent of that produced in the United States. The production in 1927 was 100,756 tons, or the highest on record in the state.

Mica

For years North Carolina has been the leading mica producing state of the Union. During the past few years, however, the production has been steadily decreasing. The decrease in production is due to foreign competition especially from India, South Africa and France. It is said that the foreign mica can be shipped to the Spruce Pine mills cheaper than it can be produced in that district. If the present tariff bill now being considered by Congress passes it is probable that the production of mica in North Carolina will be greatly increased in the next few years.

Quartz

The production of high grade quartz or "flint" has been steadily increasing for the past few years. The production so far has been from the pegmatite deposits in Mitchell and Yancey Counties and from Gaston County. Recently large deposits of quartzite which ran above 99 percent pure were discovered in Transylvania and Buncombe Counties. A quartz grinding plant has been under consideration for the past few months but the freight rates to the ceramic centers are so high that it is doubtful that the plant will be built for some time yet. If white ware plants are located in the state, two or three of which are now contemplated, the quartz production will be greatly increased. The supply of crude material is ample for many years consumption.

CLAY PRODUCTS

Common Brick

The State of North Carolina has an abundance of shale and river bottom clays suitable for heavy clay products. The production of these materials are increasing annually. In 1927 there were 64 common brick plants operating in 41 counties of the state. These plants produced 249,559,000 brick valued at $2,335,059. A great deal of attention has been paid in the past few years to details in the manufacture of common brick and as a result a better and more homogeneous brick has been put on the market. From year to year in the past five years the increase in production has just about kept pace with the extensive building program put on in the state.

Face Brick

The high grade brick made in the state are manufactured from the shales of the Triassic basin of Deep and Dan Rivers and from the pre-Cambrian shales of Stanly, Union and Davidson Counties. In 1927 a brick plant was built near Hendersonville to manufacture buff face brick from the light colored clays of Henderson County. A new face brick plant is being built near Madison which will use the Triassic shales of the Dan River area of Rockingham County. In 1927 nine plants produced flashed face brick, one buff face brick and one hollow brick. These plants produced 44,003,000 face and hollow brick valued at $709,447.

Tile

Tile, such as building, drain, sewer, etc., was produced in five counties of the state in 1927. It is manufactured chiefly from the Triassic shales of Deep and Dan Rivers. The total production was 70,276 tons valued at $798,752. In 1928 one new tile plant was built in Forsyth County to manufacture all types of drain and sewer tile from the Triassic shales.

The total value of the production of heavy clay products in 1927 was $3,862,186, which is slightly less than $4,256,901, the total produced in 1926.

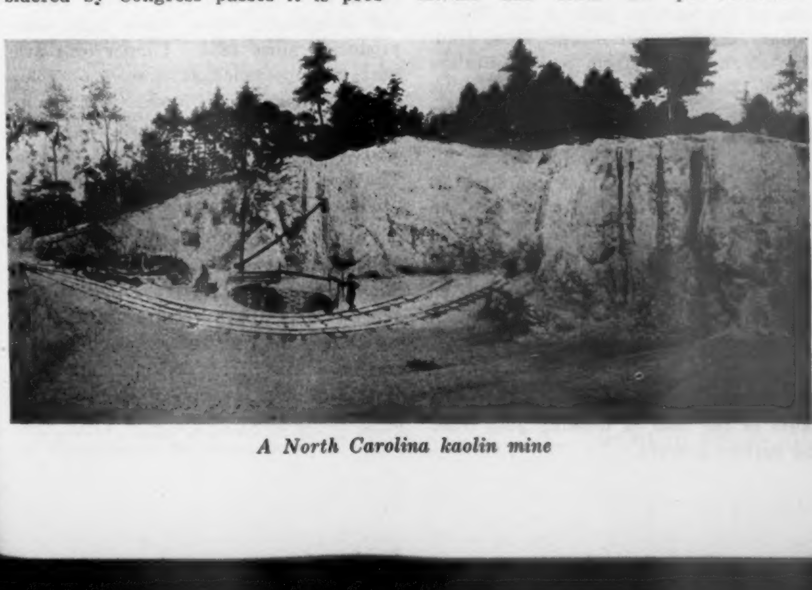
STONE

Granite

The stone industry in North Carolina is the largest mineral industry in the state. In 1927 the total value of production was $4,932,692, or over $600,000 more than that of any year in the history of the state. Granite is the most important stone produced, the total value in 1927 being $4,454,468, and came chiefly from Rowan, Surry and Vance Counties. The granites of North Carolina rank with the best produced in America.

Marble and Limestone

Considerable activity has been shown recently in the marble belt of Cherokee County. A Georgia company has recently taken over the property of the old Regal Blue Marble Company and is now doing extensive core drilling near the village of Marble. J. A. Martin, of Andrews, reports that he has practically completed his plant near Marble. He stated that he expected to produce building stone, tombstones, crushed stone, chips for terazzo flooring, lime and hydrated lime. He also expects to carry on certain tests relative to the extraction of mangnesium from the dolomitic marble. If developments continue along the present lines in the marble area, North Carolina should become an important marble producing state. Several thousand dollars have already been expended for properties, core-drilling and machinery. The future



A North Carolina kaolin mine

looks very promising in that particular field.

Talc

The developments in the talc and pyrophyllite deposits in North Carolina have been very rapid in the past year. One new plant has been built at Glendon by the United Talc & Crayon Company. Another plant is under consideration at Staley in Randolph County. Prospecting carried on so far has revealed a very large and important deposit of high grade pyrophyllite. The plant will probably be built at an early date.

Considerable interest has also been shown in the talc deposits of Yancy and Watauga Counties. No talc has been produced from these counties although several years ago quite an industry was built up by the production for tombstones. Practically every grave yard in these counties has some talc tombstones.

The total value of the mineral production in North Carolina during the past four-year period is given below. The production increased at about $500,000 per year in 1924, 1925 and 1926, but in 1927 the increase was over $1,000,000. This great increase was chiefly in stone, feldspar and copper.

Year	Value
1924	$10,163,437
1925	10,699,422
1926	11,274,224
1927	12,566,882

CALIFORNIA MAKES NOTABLE CONTRIBUTION TO WORLD'S METAL PRODUCTION

The notable part played by California in contributing to the metal production of the world is emphasized in an historical summary of metal production in that state during the 78-year period, 1848-1926, made by the United States Bureau of Mines, which shows that during this period the state produced gold, silver, copper, lead and zinc to the value of $2,059,000,000. Of this total, the value of the gold output is nearly 88 percent; silver, 3 percent; copper, 8 percent; lead, 0.6 percent; and zinc, 0.4 percent.

A total of 663,763 tons of metal has been produced since mining began, and by this standard copper ranks first, with 75.67 percent; lead second, with 16.37 percent; zinc third, with 7.10 percent; gold fourth, with 0.45 percent; and silver fifth, with 0.41 percent.

Over half a billion dollars worth of gold bullion was produced during the decade of 1851 to 1860; this was nearly double the output of the next largest decade, 1911 to 1920, during which the greatest quantities of copper, lead, and zinc of any on record were produced. California has been called the "Golden State" because its gold mines have been far more productive of wealth than any other metal mines in the state. The gold-lode mines have yielded a nearly uniform amount, over $100,000,000 a decade, during the last 45 years. The forced cessation of hydraulic mining in 1884 is clearly evident in the drop of placer-gold production between the decades 1871 to 1880 and 1881 to 1890. The gold yield increased in the decade 1901 to 1910, however, due to the large recoveries by dredges.

The silver output is so closely connected with that of other metals that the decade figures are not particularly instructive. The large increase in the decade 1881 to 1890 reflects the operations in the Calico District in San Bernardino County. Since 1901 the increased silver output is mainly due to the production from the California Rand Silver (Inc.).

Copper did not become an important element in the metal output of California until the opening of the Shasta County belt in 1894. This source of copper was augmented in 1915 by the Plumas County belt, which in that year began large-scale production. The Foot Hills copper belt has been a source of a relatively small yearly supply of copper since 1862.

In the early days of local smelting a fairly steady production was maintained by the lead mines of the desert region, until the lowering of the price of silver in 1893. Lead mining was not again revived until the decade beginning with 1911, and most of this revival came after 1914, when the prices of all metals increased. With the post-war fall in the prices of both silver and lead many mines have been shut down.

Zinc was first produced in California in 1906 as a small by-product of some of the copper ores of the Foot Hills belt. The zinc-mining industry can be said to have begun with the opening of the zinc ore bodies in the Cerro Gordo district in 1907, and for a while much oxidized ore was produced. The larger part of California's zinc has come from the treatment of the mixed copper-zinc sulphide ores of the eastern part of the Shasta County copper district and from lead-zinc sulphide ores from Santa Catalina Island, Los Angeles County, and from Orange County. Most of this zinc has been produced since the advent of selective flotation concentration.

The output of gold for the first 13 years of mining in California was the result of working surface placers by sluice box, rocker, and long tom. The yield subsequent to 1849 did not fall below $41,273,000 a year and reached a peak of $81,294,700 in 1852. Although quartz mines were discovered in Nevada County in 1850, the output of these deposits was little before 1860, largely because of the ease of winning gold from the surface placers.

Hydraulic mining was started in 1852 at Nevada City. By 1865 this method of placer mining was well established, and the years 1866 to 1876 were notable for their gold yield from hydraulic mines. In 1876, however, the agricultural interests in the valleys began litigation over the débris problem. The suits resulted in practically closing hydraulic mining in the Sierra Nevada Mountains and led to the Sawyer decision of 1884, which virtually prohibited hydraulic mining in the watershed of the Sacramento and San Joaquin Rivers. Some relief for the hydraulic miners was anticipated from the Federal Caminetti law, passed in 1893, but hydraulic mining, except in Siskiyou and Trinity Counties, has not been important since 1884.

Drift mining on the ancient buried channels was started at Forest Hill, Placer County, in 1852 and was an important source of placer gold by 1866. During the period beginning about 1876 and continuing to about 1890 drift mining was most productive.

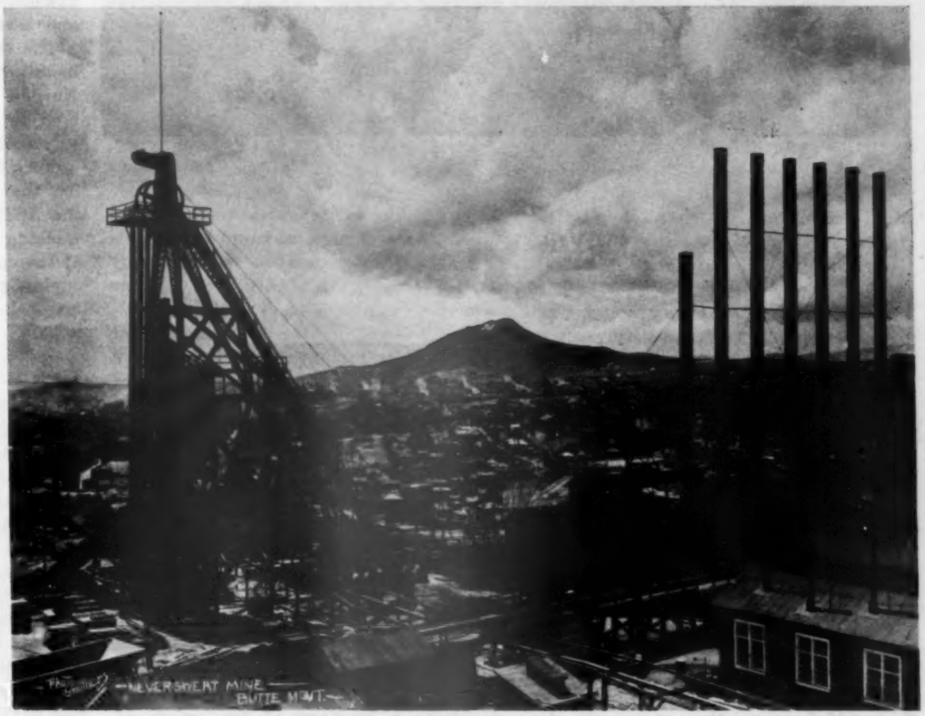
Dredge production began on the Feather River in 1898 after several years had been spent in preliminary work. This industry rapidly spread to the Yuba, Bear, and Sacramento Rivers, and later practically all the streams on the east side of the Great Valley were dredged. For a number of years the gold produced by dredges averaged nearly $7,500,000 a year. The largest amount, $8,313,527, from 55 boats, was produced in 1917. Since 1921 the dredge yield has shown a tendency to decline; much of the known dredging ground has been worked out, and the number of boats in operation is diminishing yearly.

California deep mines are predominantly gold lode mines. For the two and one-half decades for which there are adequate data 96 percent of the gold produced by all lode mines of the state has come from siliceous ores. The great bulk of the lode gold produced has come from the mother lode and from Grass Valley and Allegheny, whose mines have been producing since 1852. Copper ores are next in importance as sources of gold, and the Shasta and Plumas County copper mines have been the most important sources of gold from this class of ore. The gold yield from lead and zinc ores produced in California is insignificant.

Further details are given in Bureau of Mines Economic Paper 3, "Historical Summary of Gold, Silver, Copper, Lead, and Zinc Produced in California, 1848 to 1926," by James M. Hill, copies of which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a price of 5 cents.

MONTANA SCHOOL OF MINES

the "Freiberg of America"



"Through the Headframes." In the left background are the Montana School of Mines buildings. The picture illustrates the close connection of the industry and the school

By F. C. GILBERT*

IF THERE is one outstanding characteristic of this heterogeneous mixture of nationalities which we call the American people, it is a universal and increasing belief in education.

Without entering into any argument as to the place of cultural education in a nation with a continent to subdue, we have been, and will be, for some time to come most concerned with technical or professional education.

Underlying all human activities is the mineral industry; this is true even of agriculture, for without it mankind would still be ploughing the earth with a sharp stick and reaping his grain with a cradle.

It is interesting to note how early and how clearly the need of education for the miner was expressed.

Georgius Agricola, in the classic, "De Re Metallica," so admirably translated from the Latin by Mr. and Mrs. Hoover, writing in 1550, on "what every miner should know," drew up a standard curriculum which, in abbreviated form, we may be permitted to quote:

GEOLOGY; "that he may know . . . what mountain, what valley . . . can be prospected most profitably." Chemistry and mineralogy; "that he must be familiar with the many varied species of earths . . . metals . . . compounds." Mining engineering; "he must have a complete knowledge of the method of making all underground works." Metallurgy; "Lastly, there are the various systems of assaying and of preparing substances for smelting."

Supplementing these technical subjects he adds, "are many arts and sciences of which the miner should not be ignorant. First, philosophy, that he may discern the origin, cause and nature of subterranean things. Second, medicine, that he may be able to look after (the health of) his diggers. Third, astronomy, that he may judge the direction of the veins. Fourth, surveying, that he may be able to estimate how deep a shaft should be sunk. Fifth, arithmetical science . . . that he may calculate the cost in the working of the mine. Sixthly, architecture, that he himself may construct the various machines and timber work required underground. Next, he must have a knowledge of drawing. Lastly, there is the law, especially that dealing with metals."

The broad and comprehensive nature of the education of a mining engineer can not be better expressed today.

Apropos of the subject of medicine, we have heard of an American mining operator in a remote district in Mexico, who, in a grave emergency, was called upon to officiate as a widwife, with satisfaction to all concerned.

AGRICOLA'S professional career covered many years of active participation in the mining operations of his native region, the Hartz Mountains, in southern Germany and Bohemia.

Here were located the already old and

Necessity for mining education noted by Agricola in 1550—Growth of mining training traced—Mining schools follow the development of mining fields—Practical application of School of Mines work to Montana problems—Local employment in mines assists students financially

* Acting Professor of Metallurgy, Montana School of Mines, Butte, Mont.
Eighth in a series of articles on Mining Schools of Distinction in the United States.

"A school set on a hill cannot be hid"

well established districts of Freiberg (discovered in 1170 A. D.) and Goslar (worked by Otho the Great in 936-973 A. D.).

Up to some 10 or 15 years ago, Freiberg had produced lead, silver, copper and zinc ores and extracted the metals in neighboring smelting works, continuously for nearly 800 years. It was reported in 1875 that the underground workings were 600 miles in length and 2,000 feet deep, most of which were without the use of powder.

The Bergakemie of Freiberg, the oldest mining school in the world, was founded in 1765 for the training of miners of Saxony. The proximity of the varied mining and smelting operations of Central Europe and its outstanding professors of geology and metallurgy attracted students from all over the world for more than a century. Its graduates were to be found in every country; their achievements attesting the high scholastic standards of the institution.

To the American student, although handicapped by unfamiliarity with the language, and with the German university method of lectures and final examinations, there were two great advantages of the Freiberg school over the American college of the period. First, the free and informal relations with the professors, and, second, the close association of the school with the practical work of the numerous mines and smelters. This latter feature seems worthy of the most careful attention of our American mining schools.

Under a unique system of government ownership and operation of the mines in conjunction with state administration of the Freiberg Academy, the holder of a student card was accorded the fullest cooperation by the officials in charge of the mines in his study of the methods and processes used. He was allowed access to all records, including cost of operation and metallurgical recoveries; he was permitted to take his place with the miner in the stope or to try his hand with the "dolly"[1] at the furnace, where he found the same sympathetic interest on the part of the workmen and overseers in a democracy of craftsmanship, doubtless a heritage of the guilds of medieval times.

IT MAY not be out of place for the writer to recall the first years of his smelting experience at one of the plants founded and managed by the late Anton Eilers, himself a Freiberger. Everywhere was apparent the utmost loyalty and mutual understanding between the superintendent, foremen and workmen extending to the younger men of the technical staff, all dominated by the strong and kindly personality of the owner-manager who valued science and fair dealing as well as dividends.

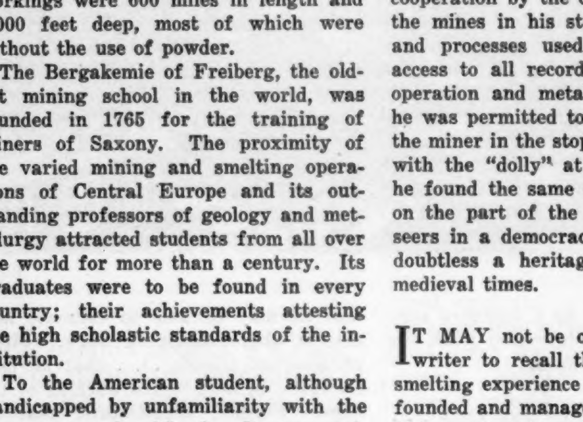
The closing of the mines at Freiberg has, we understand, resulted in the abandonment of the school, after a long and useful life.

The story of 800 years of mining and metallurgy in the mountains of Central Europe finds its counterpart in every land on the face of the earth. The history of America is the story of its prospectors from the time of Columbus sailing the seas for the gold and silver of the Indies, to the lone placer miner washing the streams in remote corners of the continent, followed by the mining engineer and the great mining, metallurgical, and manufacturing corporations.

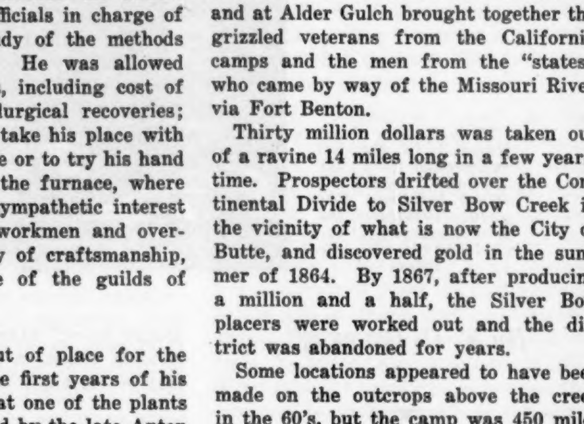
RICH placer gold deposits were discovered in Montana in 1862 at Bannack. The news of the rich finds here and at Alder Gulch brought together the grizzled veterans from the California camps and the men from the "states" who came by way of the Missouri River via Fort Benton.

Thirty million dollars was taken out of a ravine 14 miles long in a few years' time. Prospectors drifted over the Continental Divide to Silver Bow Creek in the vicinity of what is now the City of Butte, and discovered gold in the summer of 1864. By 1867, after producing a million and a half, the Silver Bow placers were worked out and the district was abandoned for years.

Some locations appeared to have been made on the outcrops above the creek in the 60's, but the camp was 450 miles from the nearest railroad—too far to ship the silver ore to the smelters in Swansea, where the rich silver ores of Colorado were successfully treated. Local methods of extraction had failed. It was not until the late 70's that the first roasting and smelting of the silver and copper ores was accomplished.



Seniors in physical metallurgy



The Mineralogy Laboratory

The story of the discovery and exploitation of "the richest hill in the world" has been the theme of many a romance from "Frenzied Finance" to articles in our magazines by popular novelists, one of whom by his own admission was unremittedly devoted to the great American game during his stay in our metropolitan city. These lurid accounts of the early times, at standard rates per word, have been more entertaining than informative and are a thorn in the flesh of our most respected citizens. Some reliable data may not, therefore, be amiss.

From the Gymnasium steps. Butte Hill, in the background, has produced $2,000,000 worth of minerals and contains 3,000 miles of underground workings

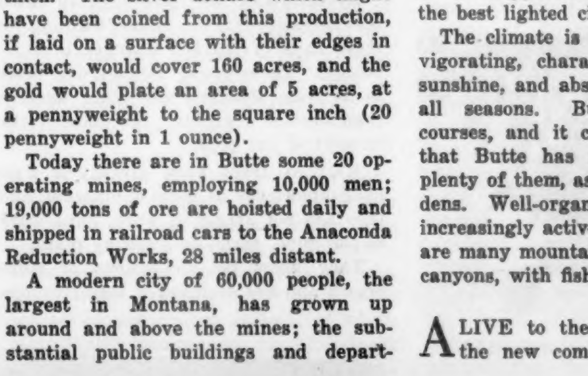
UNDERLYING the city of Butte and vicinity, from an area 3 miles long and 1 mile wide, in a network of veins which have been explored to a depth of some 3,000 ft. with no signs of "petering out," 100,000,000 tons of ore have been mined, trammed, hoisted to the surface and hauled in railroad cars to local smelting plants where 10,000,000,000 lbs. of copper, 2,000,000,000 lbs. of zinc, 350,000,000 ounces of silver, and 1,600,000 ounces of gold have been extracted and shipped to seaboard markets.

This tonnage of ore is equivalent to a solid rock 35 ft. high and a mile square. The copper would form a cap over this area 9 in. thick, the zinc a cap 2 in. thick. The silver dollars which might have been coined from this production, if laid on a surface with their edges in contact, would cover 160 acres, and the gold would plate an area of 5 acres, at a pennyweight to the square inch (20 pennyweight in 1 ounce).

Today there are in Butte some 20 operating mines, employing 10,000 men; 19,000 tons of ore are hoisted daily and shipped in railroad cars to the Anaconda Reduction Works, 28 miles distant.

A modern city of 60,000 people, the largest in Montana, has grown up around and above the mines; the substantial public buildings and department stores, the public and private schools, churches, Y. M. C. A. building, Knights of Columbus building, and country clubs are a credit to any community. The great electrical development of the region, the second in the United States, supplies low cost power and light and it is no exaggeration to say that Butte is the best lighted city in the West.

The climate is dry, healthful and invigorating, characterized by maximum sunshine, and absence of high winds at all seasons. Butte has three golf courses, and it can no longer be said that Butte has no trees. There are plenty of them, as well as beautiful gardens. Well-organized garden clubs are increasingly active. Within a few miles are many mountain streams and wooded canyons, with fishing and hunting.



The Museum of Mineralogy

ALIVE to the educational needs of the new communities springing up in the wake of the gold discoveries, then far from civilization, Congress passed the Morrill Act in 1862, providing for schools of agriculture and mechanic arts. The first step taken by the National Government in the promotion of mining education was the "Enabling Act" of 1889, in pursuance of which the states of North and South Dakota, Montana, and Washington were admitted to the Union. The act provided for the support of a school of science or school of mines in each of the new states from the rental and sale of public lands. In Montana, 100,000 acres were allotted for a school of mines.

Though not immediately available, this was equivalent to an endowment of a million dollars or more. With these lands as a basis of a bond issue afterward declared unconstitutional, $120,000 was raised, and in 1896 the first mines building was erected on a plot of land adjacent to the city of Butte, donated most appropriately by its public-spirited citizens, from portions of the Mint and Vanderbilt Lodes and the Montrose addition.

The following paragraph is found in the first announcement of the school, quoting from an authority on mining education:

"It is an axiom of modern education that any school, which is to obtain the greatest return for the money and energy in establishing it, must be in a region which, from its very nature, serves, free of all expense, as a part of the real equipment of that school."

THE Montana School of Mines was formally opened to students September 11, 1900. Professor Nathan R. Leonard was the first president. He was born at Columbus, Ohio, in 1832, graduated from Yellow Springs College at Kossuth, Iowa, studied at Harvard University, from which institution he received his A.M. degree in mathematics.

In 1860 he was called to the chair of mathematics and astronomy at the University of Iowa, where he served for 27 years, the greater part of which period he was dean of the faculty; he was act-

Looking north toward Big Butte

ing president of the university from 1866-1868 and again in 1870-1871. His highly scholastic attainments and wide administrative experience were of the greatest value.

President Leonard was succeeded in 1906 by Prof. Charles H. Bowman, who continued the high scholastic tradition established by his predecessor. In 1918 Dr. C. H. Clapp became president and, being a distinguished geologist, he added the emphasis of his own calling to the curriculum of the school, and upon Dr. Clapp's promotion to the presidency of the State University, he was succeeded by George W. Craven, professor of mechanics and mathematics. During President Craven's term of office practically all of the recent buildings of the School of Mines were completed, and much credit is due him for the excellent present condition of the physical plant.

Our first alumnus, Louis V. Bender, now superintendent of the Anaconda Reduction Works, was graduated in 1903.

To date, 225 men and 2 women have received degrees and occupy an important place in the mineral industry of the United States and foreign countries.

This number does not include the many special students of mature years who came from mining industry to the School of Mines for shorter or longer periods and immediately returned to assume larger responsibilities.

In 1908 a second building was completed; in 1923 two more buildings were added; in 1925 the gymnasium was opened; a total of five buildings.

1. Main building with the administrative offices, library, reading room, geology, physics and English departments.

2. Mill Building, housing the general heating and power plant, ore dressing and assay laboratories.

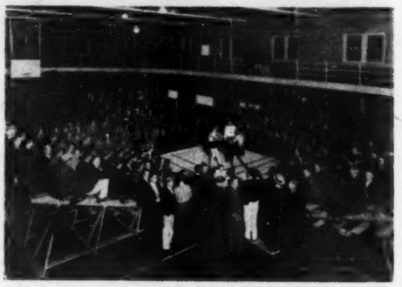
3. Engineering Building, devoted to the work in mining engineering, surveying and drafting.

4. Metallurgical Building, caring for the chemistry and metallurgical departments.

5. Gymnasium, equipped with a large playing floor, swimming pool, handball courts, running track and other facilities.

Three four-year curricula lead to degrees of Bachelor of Science in mining, in metallurgical, and in geological engineering.

THE school year is divided into two semesters of 18 weeks each with 28 to 30 hours of classwork (18 to 20 credit hours) per week. A brief summary of the curricula is as follows:



Montana students entertaining seniors from Golden on their annual trip. March, 1929

The freshman-sophomore "rush"

Freshman Year (common to all degrees)

	Hours per week
1. English and Economics	5
2. Mathematics and Surveying	6
3. Chemistry	11½
4. Mechanical Drawing	7½
Total hours per week	30

Summer field work in plane surveying 4 weeks, required for all degrees.

Sophomore Year (common to all degrees)

1. English	2
2. Mineralogy and Geology	7½
3. Mathematics and Physics	8
4. Chemistry	8
5. Surveying	4½
Total hours per week	30

Summer field work in mine surveying for degree in Mining Engineering.

	Hours per week: Mining	Metallurgy	Geology
Junior Year			
1. Economics	2	2	2
2. Geology	4½	4½	12½
3. Metallurgy	2½	4	1½
4. Mining and Mining Law	8½	½	4
5. Mechanics, Mathematics, Physics	8½	8½	3
6. Assaying, Chemistry	2½	10	6½
Total hours per week	29½	29½	29½

Summer field work in geology—Mining, 2 weeks; geology, 2 weeks

	Mining	Metallurgy	Geology
Senior Year			
1. Metallurgy	10½	18	4½
2. Mining	3	....	....
3. Ore Dressing	8	8	....
4. Geology	6½	....	25½
5. Mechanics	2	2	....
Total hours per week	30	28	30

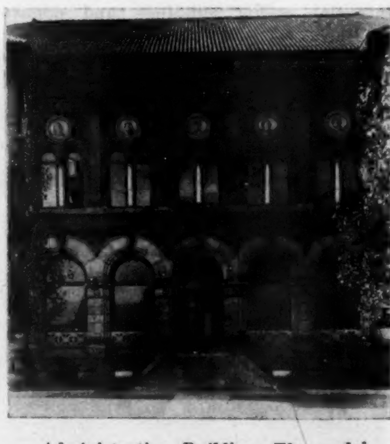
THE Montana School of Mines stresses the fundamentals of mathematics, physics, chemistry, and geology; the work of the first two years being the same for all degrees, and including a liberal amount of humanistics.

In the junior year begins the differentiation of the courses which are still more specialized in the senior year.

Nevertheless, we have kept in mind the necessity for a broad training in these days of marked changes in technology. These young fellows who come to us from Montana and other western communities represent the most virile element of our pople.

Most of them have already a first hand knowledge of some occupation, and they are not afraid of work, hard work in the mine, farm, or smelting plant.

They know the limitations of mere brawn and are desirous of better things.



Administration Building. The medallions in the upper facade, from left to right, are Franklin, physics; Hunt, geology; Gaetzchmann, mineralogy; Percy, metallurgy; and Holley, chemistry

Their experience has given them a bit of worldly wisdom so that they are at times too much inclined to scrutinize and weigh scientific problems in the scales of immediate financial return. The broader point of view, naturally, comes to them later. In the meantime, many of them are without sufficient financial resources.

By a most liberal and sympathetic attitude of the officials of the local mining companies any students are able to find employment, not to exceed two shifts per week in the mines.

It is remarkable how well the boys fit into the regular mining operations. There is no coddling; the Irish or Cornish boss sees that they do their bit; on the other hand, they get a square deal. Some of them hold their own on contract work with the skilled miner; the variety of jobs held is by no means a small factor in this extra-curricular education; in the course of a year or two, the student may be switched from top man, cageman, to timberman, trammer, motorman, drillman, mucker, sampler; no distinctions are made for or against him. The free measuring of the fellow craftsman is as characteristic of Butte as it was of Freiberg. Here, a man is a man whatever his nationality or education. If he does his work, he draws his $5.75 or more (with copper above 20 cents).

To men accustomed to the reality of stope or furnace the instruction of the class room and laboratory drives home the fact already acquired, or opens up a new channel of thought from some experience already gained.

IT MAY not be necessary to remind the mining engineer that the normal Montanan is not given to undue reticence about the superiority of his native or adopted state. In fact, with an area of 147,000 square miles (the third largest in the United States), of which some 19,000 square miles are bituminous coal land, with 25,000 square miles of lignite, with three transcontinental railways, and with Yellowstone Park to the south and Glacier National Park within its borders, we find it hard to curb our statements to those bounds of courtesy due to others less favored in their natural sorroundsings.

However, we have only 600,000 people in Montana, about 4 to the square mile, so we may assure those desirous of sharing our advantages, that there is plenty of room for them.

AMONG those who have been recently attracted to our community is our new president, Dr. Francis A. Thomson, who came to us last July.

Born in England December 21, 1879, he is educationally an American product: E.M. 1904, M.S. 1914, Colorado School of Mines. For a number of years he was a mining and consulting engineer in the mines of Colorado, Nevada, and Canada. In 1907 he became head of the Department of Mining Engineering at the State College of Washington. In 1917 he was called to the University of Idaho as dean of the School of Mines. In 1919 he became director of the Idaho Bureau of Mines and Geology, which has been one of the most productive of the western state surveys. In 1923 he received the degree of Doctor of Science from his alma mater.

He comes to us with a record of high technical and academic achievement, filled with an unbounded faith and enthusiasm for the professions which serve the mineral industry.

The Montana School of Mines, under his guidance, should achieve the high purpose of its founders.

PROGRESS IN METAL MINE VENTILATION

While coal mines are usually compelled by state law or by the existence of explosive gas to establish some sort of ventilating system, most metal mines in the absence of compulsory legislation, rarely pay particular attention to air flow unless prompted to do so by unfavorable underground working conditions, says Dan Harrington, chief engineer, Safety Division, United States Bureau of Mines, in reviewing recent progress in metal-mine ventilation. Laws as to ventilation of metal mines are practically non-existent, Mr. Harrington points out. Despite this situation, metal mines continue to encounter numerous dangerous gases; in fact, metal mines appear to have a greater variety of dangerous gases than are to be found in coal mines.

The recent occurrence of a number of deaths from heat stroke in the deep gold mines of the South African Rand demonstrates that in hot metal mines, not only the efficiency, but also the very lives of the underground workers must depend upon the finding of some efficient method of cooling air. The fatalities in the South African gold mines occurred in practically saturated air with temperatures between 85 and 91 degrees F. Such temperature and humidity conditions are to be found in a considerable percentage of the working faces in many of the deep metal mines of the United States.

The use of ice in cooling working faces in the gold mines of Australia and South Africa is referred to by Mr. Harrington. In Australia ice has been used for cooling mine air at the time of blasting to accelerate the removal of fumes from the atmosphere. In the United States attention is being directed to the problem of mine-air cooling and conditioning, and various suggestions as to the application of refrigeration methods have been advanced. Although application of some form of local cooling or conditioning of air will be necessary in some mines, the most effective remedy for the "conditioning" of air at working places is the continual circulation of relatively large volumes of fresh pure air from the surface to and past the places where men work. The best remedy for the relief of hot humid air in mines is the operation of an adequate ventilation system.

Although little is heard concerning the health hazard from dust in mines, the hazard continues to exist, Mr. Harrington points out. Although some alleviating practices have been installed and used in progressive metal mines—such as extension of ventilation, use of wet drilling, use of water sprays, water blasts, and shooting largely if not wholly at the end of the shift—nevertheless both in the United States and in other countries which use more drastic methods for prevention of mine-air dustiness, there continue to be much silicosis and other kindred diseases due largely, if not wholly, to dust.

The opinion that metal mines are essentially immune to fire is too prevalent throughout the world, says Mr. Harrington, and not until it is realized that all metal mines, even those which are essentially wet, have a definite fire hazard, will there be a cessation of the metal-mine fires causing loss of life out of all proportion to the amount of the fire itself.

Control of air flow is the essential point of any mine ventilating system, and is obtained only by the installation of mechanically operated fans, and other ventilating devices, such as doors, overcasts, regulators, etc. Every mine, large or small, coal or metal, should from the outset be equipped with a fan. Much has been written about natural ventilation, and many claims have been made that in specific mines or parts of mines there is sufficient natural air flow. As a matter of fact, there are very few, if and mines, coal or metal, where natural ventilation creates atmospheres adequately safe or healthful for underground workers even under ordinary conditions; and at the time of a fire or an explosion mines depending upon natural ventilation are practically helpless, and are decidedly dangerous for the unfortunates forced to be in them either at the time of the disaster or afterwards when trying to handle conditions arising from the emergency.

Further details are given in Information Circular 6136, "Progress in Metal Mine Ventilation," copies of which may be obtained from the United States Bureau of Mines, Department of Commerce, Washington, D. C.

LEGISLATIVE Review

Congress in recess since June 19—Senate will consider tariff revision bill on reconvening August 19—House business not to resume until October 14—Farm aid and Census bills passed but repeal of National Origin provision of Immigration Law defeated in Senate

CONGRESS has been enjoying a brief recess during the heat of summer. Having completed three-fourths of its legislative program for the extra session both the Senate and House suspended activities on June 19 to permit the Senate Finance Committee to put the tariff revision bill in shape for action by the Senate. During June and part of July the committee heard testimony in behalf of various industries for adequate tariff duties and was expected to report the bill with amendments when the Senate reconvenes August 19, or shortly thereafter. As the House has completed its legislative program and will have to wait for the Senate to pass the tariff bill, the House will not reconvene until September 23 and will not transact business until October 14 unless the Senate passes the tariff bill before that time. The House will meet and adjourn on Mondays and Thursdays between September 23 and October 14.

Prior to the summer recess Congress passed and the President approved the farm relief bill and the measure authorizing a census of mines, distribution, unemployment and population on April 1 and reapportionment of the House of Representatives among the states on the basis of the latest developed population. The Senate refused to take up a bill to repeal the national origin provision of the immigration law under which effective July 1, 1929, immigration to this country was reduced by 15,000 by application of the quotas on the basis of the number of foreign born in the United States in 1790, instead of in 1890, which has been the basis for the last five years. These bills completed the legislative program for the extra session which convened April 15, except for the tariff bill, which leaders hope to enact before the regular session of Congress meets in December. A few miscellaneous bills have been passed but the House will adhere to its previous plan not to appoint all of its committees and transact all kinds of legislative business until the December session. One of the bills enacted into law authorizes the Government to bring suit to adjust the land grant to the Northern Pacific Railroad, which involves the classification of mineral lands.

When the Senate takes up the tariff bill late in August an attempt to restrict the revision to agricultural products will be renewed. The first move in this direction was defeated before the June adjournment by one vote, with 20 Senators absent or not voting.

The President's recent order restricting operations in oil and gas prospecting and leasing under the leasing law came in for further criticism from western Senators, and Senator King, Democrat, Utah, who had earlier in the session requested an investigation of the legality of the new policy, introduced a resolution to reinstate oil prospecting permits which have been cancelled since it went into effect in March.

Both Houses of Congress passed a bill to invite the states and foreign countries to participate in an international petroleum exposition at Tulsa, beginning October 5.

The following is a summary of the status of bills to the ajdournment of Congress on June 19:

S. 542. Mr. George (Dem., Ga.). To establish an assay office at Dahlonega, Ga. Transferred from the Mines and Mining to the Finance Committee.

S. 312. This bill authorizes the taking of a census of mines, distribution, unemployment and population on April 1 and to reapportion the House of Representatives on the basis of the latest population. Enacted into Law.

S. Res. 103. Mr. King (Dem., Utah). This resolution directs the Interior Department to reinstate all oil prospecting permits which have been cancelled since March 12, 1929, when the new oil conservation policy went into effect. Public Lands.

H. J. Res. 109. This resolution invites the states and foreign countries to participate in an international petroleum exposition to be held at Tulsa beginning October 5. Enacted into Law.

S. Res. 91. Mr. Borah (Rep., Idaho). This resolution proposed to confine tariff revision legislation to agricultural and related products. Defeated by the Senate.

H. R. 2667. Amendments to by Mr. Wheeler (Dem., Mont.). These amendments to the tariff revision bill proposed duties as follows: Manganese, duties of from ½ to 2½ cents per pound on ore having a metallic manganese content ranging from less than 10 percent to more than 25 percent, instead of 1 cent per pound under the present law; duty of 30 percent advalorem on chromite or chrome ore instead of free entry under the present law; increase the duty on lead-bearing ores from 1½ to 2 cents per pound. Finance.

H. R. 2667. Amendments to by Mr. Pine (Rep.) and Mr. Thomas (Dem.), Oklahoma. These amendments propose a duty of $1 per barrel on crude oil and 50 percent advalorem on refined products. Finance.

H. R. 2667. Amendments to by Mr. Glass (Dem., Va.), and Mr. Brookhart (Rep., Iowa). These amendments provide for a tax of (*Continued on page* 609)

IMPORTANT BILLS REVIEWED IN THIS ISSUE

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A summer afternoon on the Washington Cathedral grounds

PRACTICAL OPERATING MEN'S DEPARTMENT

METALS

GUY N. BJORGE
Editor

Practical Operating Problems of the Metal Mining Industry

Application of Electrical Equipment To Mine Hoists

Power analysis essential—Speed versus drum diameter discussed — Simple method of determining required ratings under all conditions—Machine losses estimated from these efficiencies

By J. E. BORLAND*

IN A PREVIOUS article published in THE MINING CONGRESS JOURNAL of January, 1929, various types of mine hoist and mechanical equipment were described. Several hoists typical of the more common forms will now be considered and calculations carried through to illustrate the method of determining the ratings, and type of electrical equipment to be applied.

Preliminary to making calculations of power requirements it is necessary to have complete information on the service for which the hoist is intended and on the mechanical design. The essential items are: Power Supply, Volts, Phase, Cycles.

In addition to the power supply characteristics noted above, if the hoist service is such as to require careful analysis to compare power costs of induction motor drive with those of direct current, variable voltage drive with an equalizer system, consideration must be given to the items of the contract under which power is purchased, such as the unit costs of power and penalties for peak loads, low power factor, etc. In a study of this sort, power demands of the hoist equipment should be considered in combination with other loads which may be present on the same meters. The occasions for such power analyses are generally in connection with coal mining hoists operating at high rope speeds on fast duty cycles.

* General Engineering Department, Westinghouse Electric & Manufacturing Company.

When power is supplied from a system of small capacity or the hoist equipment is located at the end of a long feeder, consideration must be given to the ability of the system to carry the power demands and the resultant voltage regulation. The latter is particularly important if synchronous motors are operated from the same feeder line as the hoist equipment, since the performance of synchronous motors may be seriously affected by dips in voltage. Under such conditions d.c. motor drive with a synchronous or a fly-wheel motor generator is often necessary even though there is no saving in power cost. A discussion of this question is beyond the scope of the present article.

HOISTING DISTANCE

In coal mining the hoisting distance can be readily determined, as it consists of the distance from the bottom landing to the unloading point at the surface or in the head-frame. In metal mining, however, the maximum depth of the ore-body is often unknown and in designing the hoist the probable maximum depth is estimated to take care of future requirements, sometimes with provision for reduction in skip size when operations reach great depths.

ANGLE OF SHAFT TO HORIZONTAL

In case the shaft is sunk at an angle other than 90 degrees to the horizontal the angle of inclination must be known and in the case of compound shafts, consisting of sections of different inclination, the angles of the various sections and their lengths must be known as well as the radii and length of the curves joining them.

For slope hoists it is necessary to have a profile of the entire haul showing the lengths and grades of the various sections, and if there are any horizontal curves in the track, their lengths and degrees of curvature must be known. Consideration should also be given to the size of rail and general condition of the haulage track, as well as the type of bearings used on the mine car, since these items influence the rolling friction load.

WEIGHT OF LOAD PER TRIP

For production hoists, the weight of load per trip can be determined readily from the average weight of a cubic ft. of the material and the capacity of skip or cars to be hoisted. For slope hoists the maximum number of cars to be handled in one trip should be definitely known, as well as the average number, for the size of motor required by such hoists is often determined by the maximum torque required to handle the largest trip on the heaviest grade of the slope. Where rock is handled on the coal hoist, a general coal mining practice, the maximum weight of rock load should be known as well as the number

of cars of rock to be hoisted during the shift.

In man and material hoists the weight of load is extremely variable, of course, but the maximum weight to be handled should be definitely known and preferably something of the average weight or the number of successive trips which will need to be made with heavy loading.

Weight of Car

The weight of car should be accurately known in the case of any slope or cage hoist which will operate unbalanced. This applies as well to cage hoists which may operate unbalanced in emergency or where the cage must be lifted out of balance at the landing chairs. In hoists which will operate in balance at all times the weight of car need not be known accurately, as affects only the inertia of the system.

Weight of Cage or Skip

The comments given above for the car apply likewise to the cage or skip, excepting that fairly accurate knowledge of this weight is of more importance because of its higher value compared to that of the car.

Size of Rope

The size of rope is determined by the total suspended load, including the weight of the rope itself, with due regard to additional rope stresses caused by acceleration, rope bending, etc. and the required factor of safety.

Size and Shape of Drums

As explained in the previous article, the type of drum (cylindrical, conical, cylindro-conical or reel—single or double drum) is determined by the hoisting conditions and lay-out of the hoisting plant.

In choosing the size of cylindrical drums the following points are taken into consideration:

(1) The drum diameter should be large enough to keep bending stresses in the rope within desirable limits.

(2) The drum face, within practical limit, is chosen of sufficient width to wind the required length of rope in the desired number of layers. As previously mentioned, in some localities, it is considered objectionable to wind in more than one layer and very wide drums are frequently used to meet this requirement. To keep the drum width within practical limits the diameter is sometimes made larger than necessary from consideration of rope bending.

(3) For deep mine hoisting, where clutched drums are necessary for balanced hoisting from the various levels, drums of diameters up to 12 ft. have been developed, and while in some cases consideration has been given to larger sizes, the writer has no knowledge of any installations using clutched drums larger than 12 ft.

(4) As the larger mine hoists nearly always have the motor coupled directly to the drum shaft, the smaller the drum diameter for a given rope speed the higher will be the motor speed. With other conditions met, therefore, it is frequently advantageous to choose the smaller diameter drum, for while it may not greatly affect the horsepower rating of the motor, in general, the higher speed motor will be of lighter weight and lower cost.

(5) Where the hoist is to be driven through single reduction gearing the drum diameter should be selected, if possible, so as to use gearing of practical ratio with a motor of standard speed. For single reduction herringbone gearing, ratios as high as 15 to 1 are sometimes used but a ratio within 10 to 1 is usually considered preferable. The synchronous speeds of 60 cycle induction motors most frequently applied to mine hoisting are: 600, 514, 450, 400 and 360 r.p.m.

WR^2 of Rotating Hoist Parts

Data on the WR^2 of rotating parts of the hoist, including drums, gear, clutches, couplings, head-sheavers, etc. are specified by the hoist manufacturer, usually as a single figure, referring the values of the separate parts to the drum shaft. With cylindro-conical drums it is more accurate to consider the head-sheaves separately, as their speed of rotation is not in direct ratio to the drum speed. For clutched drums, to operate at times out of balance, the WR^2 should be known for both the balanced and the unbalanced hoisting parts.

For preliminary calculations in the absence of accurate data, the WR^2 of rotating hoist parts may be approximated from the table at the foot of the page.

Rates of Acceleration and Retardation

The rates of acceleration vary widely and a careful study involving repeated calculations is frequently necessary in arriving at the most satisfactory value. This is the case particularly with hoists operating on a short-time duty cycle, of the order of half a minute or less. A difference of a second in the time allowed for acceleration, with corresponding change in the time available for full speed operation, may greatly affect the maximum speed and power requirements. In general, where a fixed time is allowed to complete the cycle the motor heating and power consumption will be less with higher rates of acceleration. On the other hand, the accelerating torque required of the motor is usually increased with the rate of acceleration beyond a certain value. The problem is to determine the rate which will result in the least motor heating and power consumption and, at the same time, keep the over-load requirements within reasonable values. At the same time, the rate of acceleration must not be so great as to exceed limitations of the mechanical equipment nor, in balanced hoists, to cause too great a decrease in the tension of the descending rope.

In general, the rate of retardation may be slightly greater than the rate of acceleration, since gravity assists in retardation. The most satisfactory rate of retardation is one which permits the speed to be reduced to zero under the combined forces of gravity and friction, with a light application of the brake at the final stop. Higher rates of retardation require additional braking forces, either by application of the drum brake or by causing the motor to develop a counter torque.

With a direct current motor operating on the variable voltage system, electrical braking is produced by a reduction in

CYLINDRICAL DRUMS

			Including			
Dia. Ft.	Face-Ft.	No.	Clutches	Gear	Sheaves	WR^2 Lb. Ft.^{2}
6	7	1	No	Yes	Yes	300,000
8	9	1	No	No	Yes	650,000
9	11	1	No	No	Yes	750,000
10	10	1	No	No	Yes	1,100,000
5	7	2	Yes	Yes	Yes	370,000
6	7	2	Yes	Yes	Yes	550,000
7	5	2	Yes	Yes	Yes	700,000
8	5	2	Yes	Yes	Yes	1,000,000
10	10	2	Yes	No	Yes	4,000,000
12	12	2	Yes	No	Yes	6,500,000

CYLINDRO-CONICAL DRUMS

		Active Turns			Including		
Small Diam. Ft.	Large Diam. Ft.	Small Diam.	Cone	Large Diam.	Gear	Sheaves	WR^2 Lb. Ft.^{2}
6	8	1.5 —	3 —	7.5	Yes	Yes	400,000
7	9	2.5 —	2 —	2.5	Yes	Yes	550,000
7	10	4 —	4 —	7.5	No	Yes	500,000
7	11	4 —	4 —	7	No	Yes	700,000
7½	10½	15	11	5	Yes	Yes	650,000
9	11	2	9	2	Yes	Yes	900,000
10	16	5	5	23	Yes	No	4,000,000
8	12	3	4	28	Yes	Yes	1,250,000

generator voltage, causing a reversal in the direction of the motor armature current and torque. The variable voltage system permits the use of devices which provide automatic retardation with great smoothness and reliability, this being one reason for its wide application to hoists operating at high speeds and on fast duty cycles.

With an induction motor braking torque below synchronous speed, as required for retardation of the hoist, can be produced by reversal of the primary connections with the proper amount of resistance in the secondary circuits. This operation being known as "plugging". Automatic control is not practicable with this system and with high speeds and fast retardation considerable skill on the part of the hoist operator is necessary in manipulating the controller and brake levers.

In determining the rates of acceleration and retardation the data on hoists of various types, given below, will be of value..

With the operating conditions of the hoist established, calculation of the power requirements is primarily a problem in kinetics. In general, the methods of procedure is to calculate for each point of the duty cycle at which there is an abrupt change in power requirement, the net moment of the hoisting and lowering loads, acceleration or retarding moment and the hoist friction, all referred to a common shaft, usually the drum shaft.

Of these factors, the hoist friction is the only one incapable of accurate determination, but as it usually amounts to less than twenty percent of the total moment, it may be seen that a rather large error in the assumed friction moment will not greatly affect the final result. Although the friction load probably varies slightly throughout the hoisting cycle, it is customary to assume it constant. One method which has been found sufficiently accurate is to take the friction load equal to five percent of the total suspended load in the case of direct connected hoists and 7½ percent in the case of geared hoists. The latter value corresponds to an overall mechanical efficiency of about 80 percent, at full load output of the hoist motor.

The examples and accompanying explanation on the following pages illustrate one method of procedure in calculating power requirements.

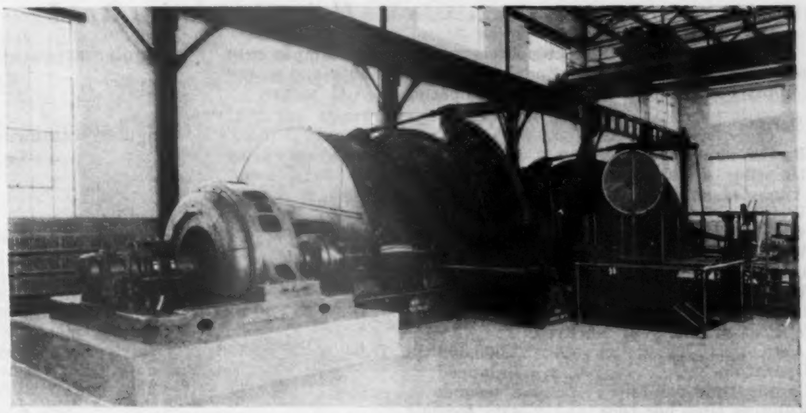


Figure 1. Cylindrical drum mine hoist driven by induction motor of type covered by Calculation No. 1.

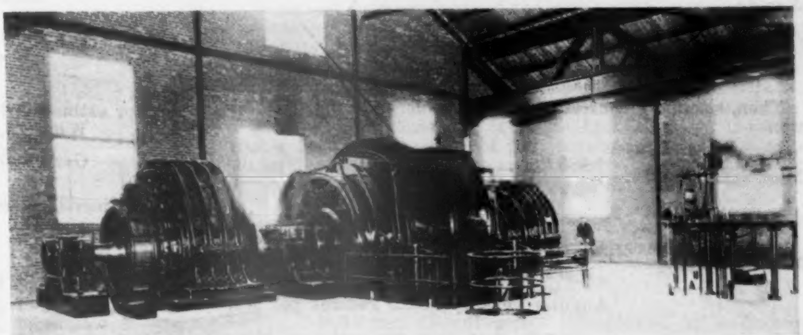


Figure 2. Large DC motors driving mine hoist of type covered by Calculation No. 2.

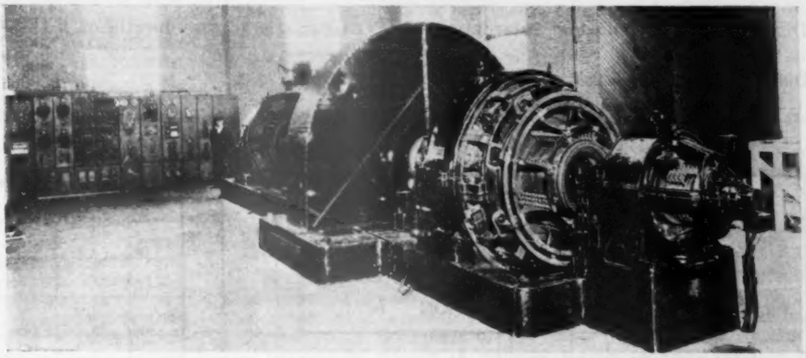


Figure 3. Flywheel motor generator set in mine hoist service.

It is believed that these calculations will serve to bring out the principles involved in determining the ratings of electrical equipment for mine hoist duty and indicate a simple and consecutive line of procedure. Considerable explanatory matter has been given to clarify various steps and this may cause the calculation to appear unduly long and laborious. However, to one familiar with this work, the entire data and calculation of a hoist for induction motor drive can be recorded on a single letter-size page, while that for direct current motor drive with a flywheel or a synchronous motor generator set requires only two additional pages.

Application of the principles shown will enable calculation of ratings required for any set of hoisting conditions. In the absence of accurate data of machine losses these can be estimated fairly closely from the efficiencies or, if these are unknown, the root-mean-square method will be sufficiently accurate in most cases.

Type of Hoist	Travel Ft. Total	Type of Drums	Max. Rope Speed Ft. Per Min.	Max. Rate Accel. Ft. Per Sec.^{2}	Max. Rate Retardation Ft. Per Sec.^{2}	Type of Drive
Shaft	850	Cyl.	900	1.5	1.8	D.C.
Shaft	153	Cyl.	1,000	3.8	3.7	D.C.
Shaft	2,500	Cyl.	2,500	2.8	4.2	D.C.
Shaft	3,000	Cyl.	3,000	3.33	3.33	D.C.
Shaft	525	Cyl. Con.	3,100	7.5	17.0	D.C.
Shaft	600	Cyl. Con.	4,050	8.0	17.5	D.C.
Shaft	315	Cyl.	1,400	4.7	3.3	A.C.
Shaft	360	Cyl. Con.	2,000	5.5	5.0	A.C.
Slope	5,000	Cyl.	1,140	1.0	2.0	A.C.

Hoist Calculation No. 1

This calculation illustrates the comparatively simple case of a balanced hoist with cylindrical drums, the duty and power supply being such as to permit application of A.C. motor.

Data:

Power supply	2,200 volts, 3 phase, 60 cycles
Hoisting distance	1,085 ft.
Angle of shaft...............	90 deg.
Weight of load.............	11,500 lbs.
Weight of car	5,500 lbs.
Weight of cage	11,000 lbs.
Rope diameter	1½in. at 3.55 lbs. per ft.
Type of drums	Double cylindrical
Diameter of drums	9 ft.
WR^2 of drums, gear, sheaves, etc.	1,000,000 lb. ft.^{2}
Operation	Balanced
Caging time per trip	8 seconds
Running time per trip	44.8 seconds
Total time per trip	52.8 seconds

Speed:

Assume—

Accelerating time	10 seconds
Retarding time	10 seconds

Then, assuming constant rates of acceleration and retardation—

$$\text{Max. rope speed} = \frac{1{,}085 \text{ ft.}}{\frac{10}{2}+24.8+\frac{10}{2}} = 31.2 \text{ ft. per second or } 1{,}872 \text{ ft. per minute.}$$

$$\text{Max. drum speed} = \frac{1{,}872 \text{ ft. per min.}}{\pi \times 9 \text{ ft.}} = 66 \text{ rev. per min. or } 1.1 \text{ rev. per sec.}$$

Angular velocity ω=6.9 radians per sec.

$$\text{Distance traveled during acceleration} = \frac{10}{2} \times 31.2 = 156 \text{ ft.}$$

$$\text{Distance traveled during retardation} = \frac{10}{2} \times 31.2 = 156 \text{ ft.}$$

$$\text{Distance traveled at full speed} = 24.8 \times 31.2 = 773 \text{ ft.}$$

Total.................................... 1,085 ft.

Angular acceleration=

$$\frac{6.9 \text{ rad. per sec.}}{10 \text{ sec.}} = 0.69 \text{ rad. per sec. per sec.}$$

Angular retardation=

$$\frac{6.9 \text{ rad. per sec.}}{10 \text{ sec.}} = 0.69 \text{ rad. per sec. per sec.}$$

Inertia:

$$\text{Drums, etc.} = \frac{1{,}000{,}000 \text{ lb. ft.}^2}{32.2} = 31{,}100$$

Motor—to include the motor inertia in the calculations it is necessary to estimate in advance the probable size of motor. With experience this can be done fairly accurately by an examination of the hoist duty. For service such as that specified the continuous motor rating can be approximated as follows:

$$\frac{(\text{Wt. load} + \frac{\text{Wt. Rope}}{2}) \times \text{Rope Speed}}{33{,}000 \times 0.8} \times 1.25$$

$$= \frac{(11{,}500 + \frac{3{,}850}{2}) \times 1{,}872}{33{,}000 \times 0.8} \times 1.25$$

Motor estimated 1,200 hp., 440 r.p.m.
WR^2=25,000 lb. ft.^{2}

$$\text{Gear ratio} = \frac{440 \text{ r.p.m.}}{66 \text{ r.p.m.}} = 6.67 \text{ to } 1$$

Motor inertia referred to drum shaft

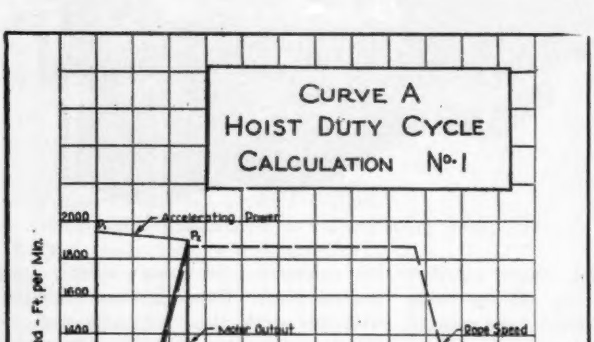
$$\frac{25{,}000 \text{ lb. ft.}^2}{32.2}(6.67)^2 = 34{,}500$$

Load—weight of load=	11,500 lbs.
weight of 2 cars=	11,000 lbs.
weight of 2 cages=	22,000 lbs.
weight of ropes (2,600′)	9,200 lbs.
Total suspended load	53,700 lbs.

Inertia of load referred to drum shaft

$$\frac{53{,}700 \text{ lbs.}}{32.2}(4.5 \text{ ft.})^2 = 33{,}800$$

Inertia of all parts referred to drum shaft 99,400



Figue 4

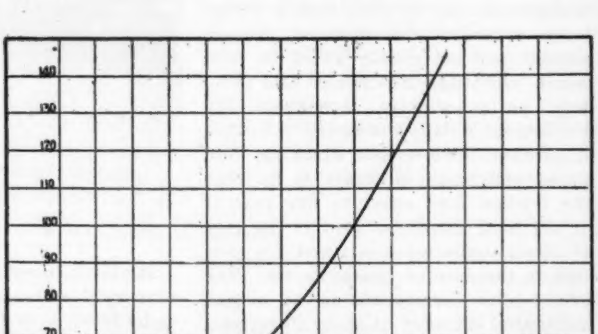


Figure 5

Accelerating and Retarding Moments:

Accelerating moment $=0.69\times 99{,}400=68{,}500$ lb. ft.
Retarding moment $=0.69\times 99{,}400=68{,}500$ lb. ft.

Friction:

Total friction load assumed 7.5% of suspended load for geared hoist $=.075\times 53{,}700$ lbs. $=4{,}040$ lbs.
Friction moment $=4{,}040$ lbs. $\times 4.5$ ft. $=18{,}000$ lbs. ft.

Torque Diagram or Duty Cycle:

	Load	Rope	Drum Radius		Friction		Acc.-Ret.		Total Moment
M_1	(11,500+3,850)		4.5	+	18,000	+	68,500	=	155,500 lb. ft.
M_2	(11,500+2,840)		4.5	+	18,000	+	68,500	=	151,100
M_3	(11,500+2,840)		4.5	+	18,000			=	82,600
M_4	(11,500—2,840)		4.5	+	18,000			=	57,000
M_5	(11,500—2,840)		4.5	+	18,000	—	68,500	=	-11,500
M_6	(11,500—3,850)		4.5	+	18,000	—	68,500	=	-16,100

Having determined the moments in pound feet at the drum shaft for the various points of the hoist duty cycle, the horsepower values required are obtained from the formula:

$$\text{Hp.}=\frac{\omega}{550}\times M$$

M = moment in pound feet at drum shaft.
ω = drum speed in radians per second.

$$\text{Then } P_1=\frac{6.9}{550}\times 155{,}000 \text{ lb. ft.}=1{,}940 \text{ hp.}$$

$$P_2=\frac{6.9}{550}\times 151{,}500 \text{ lb. ft.}=1{,}900 \text{ hp.}$$

$$P_3=\frac{6.9}{550}\times 82{,}600 \text{ lb. ft.}=1{,}035 \text{ hp.}$$

$$P_4=\frac{6.9}{550}\times 57{,}000 \text{ lb. ft.}=715 \text{ hp.}$$

$$P_5=\frac{6.9}{550}\times -11{,}500 \text{ lb. ft.}=-144 \text{ hp.}$$

$$P_6=\frac{6.9}{550}\times -16{,}100 \text{ lb. ft.}=-202 \text{ hp.}$$

The various points of the above duty cycle are plotted with respect to time in *Figure 4*. The negative values indicated during the retarding period, with an A.C. motor do not represent power returned to the motor; but indicate that braking is necessary to decelerate the hoist in the time allowed. With an A.C. motor counter-torque for braking can be developed by reversing the primary connections, this operation commonly known as plugging, but the relatively light values required for braking on the above cycle could be supplied more conveniently and economically by manipulation of the drum brake.

Motor Rating

To determine the size of motor the continuous rating and the maximum torque required must be considered. The method commonly used to determine the rating necessary to operate continuously on the duty cycle without overheating is that known as the root-mean-square, which is based on the assumption that the heating of the motor is proportional to the square of the power output. While this is not strictly correct, it is usually sufficiently close for practical purposes and has the advantage of eliminating necessity of referring to test data of the motor losses, which are seldom available to anyone save the electrical manufacturer.

As the name implies, the root-mean-square method consists in taking the square-root of the average value of hp.$^2\times$ time for the entire duty cycle. To allow for reduced rates of cooling during the rest period and during the accelerating and retarding periods, with a motor of the type and speed considered in this calculation it is usual to take only one-third of the rest time and two-thirds of the accelerating and retarding times as effective for cooling.

Continuous Rating of Motor:

By R. M. S. method—

	Hp.^{2} sec.
½ (1940^2+1900^2) 10 sec. =	36,850,000
1/3 $\left(1035^2+715^2+\frac{1035\times 715}{2}\right)$ 24.8 sec. =	19,100,000
	55,950,000

$$\text{R. M. S. hp.}=\frac{55{,}950{,}000 \text{ hp.}^2 \text{ sec.}}{2/3(10)+24.8+2/3(10)+1/3(8)}=1{,}170 \text{ hp.}$$

From Motor Losses

With test data available of the losses of the motor assumed in making these calculations, a more accurate method of determining the continuous rating necessary is to estimate the average effective loss on the duty cycle, allowing for reduced ventilation during the rest period and the accelerating and retarding periods as in the case of the r.m.s. method. *Figure 5* shows losses of the 1,200-hp. 440-r.p.m. induction motor for the full range of load required by the duty cycle. Referring to this figure the motor losses at the various points of the duty cycle are found to be as follows:

	Hp.	Hp. Loss
P_1	1940	131
P_2	1900	127
P_3	1035	66
P_4	715	54
P_5, P_6	Motor disconnected. Retardation by mechanical braking.	

From these values the total energy loss in the motor during the duty cycle, which represents the heat that must be dissipated is:

½ (131 hp. + 127 hp.) 10 sec. =	1,290 hp. sec.
½ (66 hp. + 54 hp.) 24.8 sec. =	1,488 hp. sec.
Total loss	2,778 hp. sec.

Effective average loss =

$$\frac{2{,}778 \text{ hp. sec.}}{2/3\ (10)+24.8+2/3\ (10)+1/3\ (8)}=68 \text{ hp.}$$

By reference to *Figure 5* it is found that the motor output corresponding to a loss of 68 hp. is 1,100 hp. This is the continuous rating necessary to perform the specified duty.

From the foregoing, it will be seen that the motor must be capable of developing a torque equivalent to 1,940 hp. A motor with a continuous rating of at least 2.4 full load torque would be applied to this duty. It is necessary to have a reasonable margin in pull-out torque to allow for the reduction in this value, which occurs at start and in case of reduced line voltage.

Hoist Calculation No. 2

This calculation illustrates the more complicated case of a large capacity coal mine hoist operating on a fast duty cycle and requiring the use of a cylindro-conical drum to reduce the peak loads during acceleration and retardation. As previously mentioned, for duty of this sort, a number of calculations must be made to determine the most advantageous drum shape and rates of acceleration and retardation, but only the final calculation is given herein.

Data:

Power supply ....2,200 volts, 3 phase, 60 cycles.
Hoisting distance ....607 ft.
Angle of shaft ....90 deg.
Weight of coal ....22,000 lbs.
Weight of skip and yoke...............17,000 lbs.
Rope diameter ....2" at 6.3 lbs./ft.
Drum, cylindro-conical ....10 ft. to 17 ft. diam.
Active turns and feet on 10 ft. diam.....3.14 turns=100 ft.
Active turns and feet on cone..........3.5 turns=150 ft.
Active turns and feet on 17 ft. diam.....6.64 turns=357 ft.
WR^2 of drum ....3,500,000 lb. ft.^{2}
Diameter of sheaves....................12 ft.
WR^2 of each sheave...................140,000 lb. ft.^{2}
Travel of skip in dump horns..........22 ft.
Vertical lift of skip spilling coal.........10 ft.
Effective weight of empty skip in dump.11,300 lbs.
Effective weight of skip and coal at point of dumping ....32,000 lbs.
Allowable speed of skip entering dump horns ....900 ft. per min.
Output required ....1,500 tons per hour.

Average rest time ....9 seconds.
Acceleration time ....5 seconds.
Full speed running time ....6 seconds.
Retardation time before entering horns..3 seconds.
Retardation time after entering horns...3 seconds.
Total time of cycle....................26 seconds.

Because of the great power requirements, fast hoisting speed and high rates of acceleration and retardation under this duty the only practicable form of drive is the direct current motor operating on the variable voltage system supplied by a flywheel motor-generator set with automatic slip regulator to equalize the demand on the AC power line. As losses in the direct current motor and generator must be considered in determining the size of flywheel, calculation of the continuous ratings necessary are also by the loss method explained in the preceding calculation. On a duty cycle as fast as this, where the motor operates at full speed only a small part of the time forced ventilation is advantageous as it dissipates the heat developed in the motor at about the same rate throughout the entire cycle and thus permits the use of a smaller continuous rating.

In calculating the moments of the hoist duty cycle with a cylindro-conical drum the fundamentals explained in the preceding calculation apply, but the loaded and empty skips are considered separately with the drum radii from which they are suspended at various points of the cycle. Considerations must also be given to the accelerating and retarding forces acting in the suspended loads as their ropes ascend or descend the conical parts of the drum.

Drum Speed:

Revolutions of drum per trip $=3.14+3.5+6.64=13.28$ rev.

It will be noted that the requirements are that the speed be reduced to 900 ft. per min., or $900 \div 60\pi 17 = 0.28$ rev. per second of the drum before the loaded skip enters the horns.

Let $\times =$ maximum drum speed, rev. per sec.

Then $\frac{5}{2}\times = 2.5$ drum revolutions during acc.

$6\times =$ drum revolutions at full speed.

$3\left(\frac{1+0.28}{2}\right)\times = 1.92\times$ drum revolutions during ret.

$3\ \frac{(0.28\times)}{2} = 0.42\times$, drum revolutions in horns.

Total rev. of drum $= 10.84\times = 13.28$

Maximum speed of drum, $\times = \frac{13.28}{10.84} = 1.225$ r. p. s. or 73.5 r. p. m.

Angular speed of drum, $\omega = 7.7$ radians per sec.

Rope Speed:

Rope speed on 10 ft. diam. $=73.5\pi 10=2,310$ f. p. m.
Rope speed on 17 ft. diam. $=73.5\pi 17=3,930$ f. p. m.

Angular Acceleration and Retardation:

$$\text{Angular acceleration} = \frac{7.7 \text{ rad./sec.}}{5 \text{ sec.}} = 1.54 \text{ rad./sec.}^2$$

Angular retardation (first)

$$= \frac{(1-0.28)\ 7.7 \text{ rad./sec.}}{3 \text{ sec.}} = 1.85 \text{ rad./sec.}^2$$

Angular retardation (second)

$$= \frac{(0.28)\ 7.7 \text{ rad./sec.}}{3 \text{ sec.}} = 0.72 \text{ rad./sec.}^2$$

Inertia:

The effective inertia of the suspended parts is found by taking the summation of the product of each part by the square of the drum radius from which it is suspended. The sheaves are included by multiplying their actual inertia by the ratio $\frac{(\text{radius sheave})^2}{(\text{radius drum})^2}$. This summation will be somewhat less during the accelerating period than during the retardation period, because of the changes in drum radii for the loaded and empty skips.

From preliminary calculation the motor rating is estimated to be approximately 3,200 hp. and as the motor is to be coupled directly to the drum shaft the speed will be 73.5 r. p. m. This total rating will be divided between two motors each rated approximately 1,600 hp., 73.5 r. p. m., one to be coupled at each side of the drum as indicated in *Figure 2.*

		Acc.	Ret.
Drums	$\frac{3,500,000 \text{ lb. ft.}^2}{32.2}$	109,000	109,000
Two motors	$\frac{800,000 \text{ lb. ft.}^2}{32.2}$	25,000	25,000
Suspended load and sheaves		97,000	129,000
Total effective inertia		231,000	263,000

Accelerating and Retarding Moments:

Accelerating moment $=1.54\times 231,000=$ 356,000 lb. ft.
Retarding moment (first) $=1.85\times 263,000=$ 486,000 lb. ft.
Retarding moment (seconds) $=0.72\times 263,000=$ 189,000 lb. ft.

Total change in speed in ascending or descending cone $=3,930-2310=1,620$ ft./min. $=27$ ft./sec.

$$\text{Time to wind on cone} = \frac{3.5 \text{ rev.}}{1.225 \text{ r. p. s.}} = 2.86 \text{ seconds.}$$

$$\text{Linear accel. or ret. on cone} = \frac{27 \text{ f. p. s.}}{2.86 \text{ sec.}} = 9.8 \text{ ft. per sec.}^2$$

Accelerating force on loaded rope in ascending cone $=9.8$ f. p. s.$^2 \times \frac{46,000 \text{ lb.}}{32.2} = 14,000$ lbs.

Retarding force on empty rope in descending cone $=9.8$ f. p. s.$^2 \times \frac{24,000 \text{ lbs.}}{32.2} = 7,300$ lbs.

Friction:

Total friction assumed 5 percent of suspended load for direct connected hoist $=.05\times 68,000$ lbs. $=3,400$ lbs.

Friction moment $=3,400$ lbs. $\times$ 8.5 ft. $=29,000$ lb. ft.

Torque Diagram or Duty Cycle:

Sec.	Loaded Skip Rope	Empty Skip Rope	Friction	Acc. Ret.	
0	(39,000+3,800)5	—(11,300+ 0)8.5	+29,000	+356,000	= 503,000 lb. ft.
1.8	(39,000+3,720)5	—(17,000+ 140)8.5	+29,000	+356,000	= 453,000 lb. ft.
5	(39,000+3,200)5	—(17,000+1,060)8.5	+29,000	+356,000	= 443,000 lb. ft.
5	(39,000+3,200)5	—(17,000+1,060)8.5	+29,000	+ 70,000	= 157,000 lb. ft.
7.85	(39,000+2,250)8.5	—(17,000+2,250)8.5	+29,000	+119,000	= 335,000 lb. ft.
7.85	(39,000+2,250)8.5	—(17,000+2,250)8.5	+29,000	— 62,000	= 154,000 lb. ft.
10.7	(39,000+1,060)8.5	—(17,000+3,200)5	+29,000	— 36,500	= 231,500 lb. ft.
10.7	(39,000+1,060)8.5	—(17,000+3,200)5	+29,000		= 268,000 lb. ft.
11	(39,000+ 930)8.5	—(17,000+3,300)5	+29,000		= 266,500 lb. ft.
11	(39,000+ 930)8.5	—(17,000+3,300)5	+29,000	—486,000	=-219,500 lb. ft.
14	(39,000+ 140)8.5	—(17,000+3,720)5	+29,000	—486,000	=-227,500 lb. ft.
14	(39,000+ 140)8.5	—(17,000+3,720)5	+29,000	—189,000	=+69,500 lb. ft.
17	(32,000+ 0)8.5	—(17,000+3,800)5	+29,000	—189,000	= 7,000 lb. ft.

Having determined the moments in pound-feet at the drum shaft for the various points of the hoist, duty cycle, the horsepower values are obtained by the formula:

$$\text{Hp.} = \frac{\omega}{550} \times M$$

where M = moment in pound-feet at drum shaft.
ω = drum speed in radians per second.

Thus:

			Each Motor
P_1	$=7.7/550\times 503,000$ lb. ft. $=$	7,050 hp.	3,525 hp.
P_2	$=7.7/550\times 453,000$ lb. ft. $=$	6,350 hp.	3,175 hp.
P_3	$=7.7/550\times 443,000$ lb. ft. $=$	6,200 hp.	3,100 hp.
P_4	$=7.7/550\times 157,000$ lb. ft. $=$	2,200 hp.	1,100 hp.
P_5	$=7.7/550\times 335,000$ lb. ft. $=$	4,700 hp.	2,350 hp.
P_6	$=7.7/550\times 154,000$ lb. ft. $=$	2,150 hp.	1,075 hp.
P_7	$=7.7/550\times 231,500$ lb. ft. $=$	3,240 hp.	1,620 hp.
P_8	$=7.7/550\times 268,000$ lb. ft. $=$	3,750 hp.	1,875 hp.
P_9	$=7.7/550\times 266,500$ lb. ft. $=$	3,730 hp.	1,865 hp.
P_{10}	$=7.7/550\times -219,000$ lb. ft. $=$	—3,080 hp.	—1,540 hp.
P_{11}	$=7.7/550\times -227,500$ lb. ft. $=$	—3,180 hp.	—1,590 hp.
P_{12}	$=7.7/550\times$ 69,500 lb. ft. $=$	975 hp.	488 hp.
P_{13}	$=7.7/550\times$ 7,000 lb. ft. $=$	100 hp.	50 hp.

The various points of the duty cycle are plotted with respect to time in *Figure 6.* The negative values represent power returned to the variable-voltage generator during re-

tarding period. It should be noted that the horsepower values shown at the beginning of the accelerating period and end of the retarding period indicate only the torques required of the hoist motor and the armature currents necessary to supply these torques. Since the motor speed is zero at the beginning and end of the cycle, the power developed is zero, and although the armature current may be very high to supply the accelerating or retarding torques demanded, since the voltage applied is practically zero, the power input is equal only to the losses in the machine.

Motor Rating:

By reference to *Figure 7* the motor losses at the various points of the hoist duty cycle are found to be as follows:

	Output of each motor	Losses in each motor
P_1	3,525 hp.	394 hp.
P_2	3,175 hp.	330 hp.
P_3	3,100 hp.	325 hp.
P_4	1,100 hp.	62 hp.
P_5	2,350 hp.	195 hp.
P_6	1,075 hp.	62 hp.
P_7	1,620 hp.	105 hp.
P_8	1,875 hp.	130 hp.
P_9	1,865 hp.	130 hp.
P_{10}	—1,540 hp.	95 hp.
P_{11}	—1,590 hp.	80 hp.
P_{12}	488 hp.	25 hp.
P_{13}	90 hp.	2 hp.

From these values the total energy loss in the motor during the duty cycle, which represents the heat to be dissipated, is:

½ (394 hp.+330 hp.)	1.8	sec.=	651 hp. sec.
½ (330 hp.+325 hp.)	3.2	sec.=	1,047 hp. sec.
½ (62 hp.+195 hp.)	2.85	sec.=	352 hp. sec.
½ (62 hp.+105 hp.)	2.85	sec.=	238 hp. sec.
(130 hp.)	0.3	sec.=	39 hp. sec.
½ (95 hp.+ 80 hp.)	3	sec.=	253 hp. sec.
½ (25 hp.+ 2 hp.)	3	sec.=	41 hp. sec.
Total loss in each motor		=	2,621 hp. sec.

$$\text{Effective average loss (with forced ventilation)} = \frac{2{,}621 \text{ hp. sec.}}{26 \text{ sec.}} = 101 \text{ hp.}$$

By reference to *Figure 7* it is found that the motor output corresponding to a loss of 101 hp. is 1,600 hp. This is the continuous rating of the motor necessary to perform the specified duty.

From the foregoing it will be seen that two motors each of 1,600-hp. continuous rating with forced ventilation and capable of developing overloads of 120 percent for acceleration would be required for this hoist.

Generator Rating:

Preliminary calculations indicate that a generator rating of approximately 1,500 kw. would be required for each of the hoist motors. By reference to *Figure 7* the generator losses for various points of the hoist duty cycle are found to be:

	Input to each motor	Loss in each gen.
P_1	3,919 hp.	265 hp.
P_2	3,505 hp.	245 hp.
P_3	3,425 hp.	240 hp.
P_4	1,162 hp.	85 hp.
P_5	2,545 hp.	162 hp.
P_6	1,137 hp.	83 hp.
P_7	1,725 hp.	110 hp.
P_8	2,005 hp.	125 hp.
P_9	1,995 hp.	125 hp.
P_{10}	—1,445 hp.	95 hp.
P_{11}	—1,510 hp.	88 hp.
P_{12}	513 hp.	50 hp.
P_{13}	92 hp.	35 hp.
	Rest period	31 hp.

From these values the total energy loss in the generator during the duty cycle is:

½ (265 hp.+245 hp.)	1.8	sec.=	460 hp. sec.
½ (245 hp.+240 hp.)	3.02	sec.=	775 hp. sec.
½ (85 hp.+162 hp.)	2.85	sec.=	352 hp. sec.
½ (83 hp.+110 hp.)	2.85	sec.=	275 hp. sec.
(125 hp.)	0.3	sec.=	38 hp. sec.
½ (95 hp.+ 88 hp.)	3	sec.=	274 hp. sec.
½ (50 hp.+ 35 hp.)	3	sec.=	128 hp. sec.
(31 hp.)	6	sec.=	186 hp. sec.
Total loss in each generator		=	2,488 hp. sec.

$$\text{Effective average loss} = \frac{2488 \text{ hp. sec.}}{26 \text{ sec.}} = 96 \text{ hp.}$$

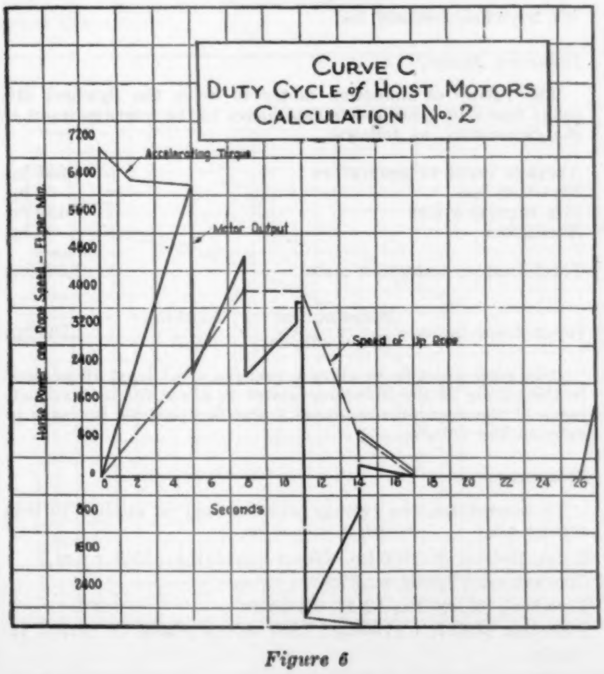


Figure 6

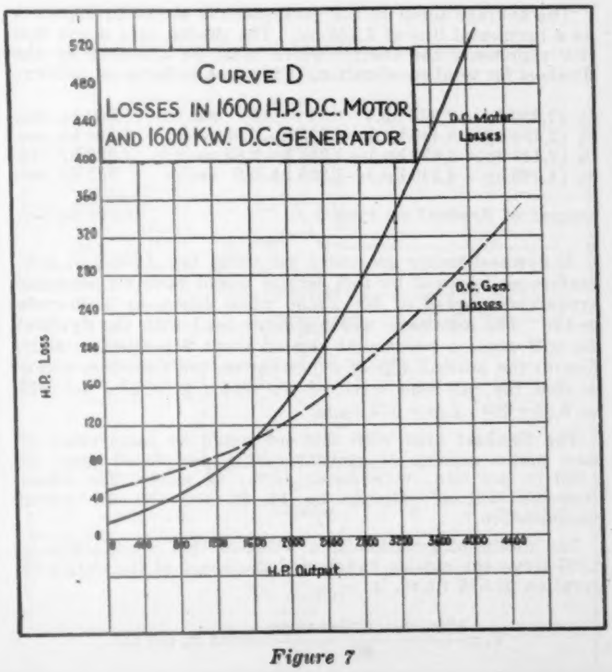


Figure 7

By reference to *Figure 7* it is found that the generator output corresponding to a loss of 96 hp. is 1,450 hp., or 1,080 kw.

From the foregoing it may be seen that two generators each of at least 1,080 kw. rating are required for this service. As the peak load for acceleration is 4,184 hp., or 3,120 kw., a generator rating of 1,600 kw. would be applied to insure good commutation under this overload.

Flywheel:

To determine the size of flywheel needed for total equalization of the demand on the AC power line, the total energy input to the generators during the hoisting cycle is calculated as follows:

INPUT TO TWO GENERATORS

P_1	1,318 hp. (Losses in motors and generators only)
P_2	3,290 hp
P_3	7,330 hp.
P_4	2,494 hp.
P_5	5,414 hp.
P_6	2,440 hp.
P_7	3,670 hp.
P_8	4,260 hp.
P_9	4,240 hp.
P_{10}	—2,700 hp.
P_{11}	—395 hp.
P_{12}	374 hp.
P_{13}	120 hp.
Rest period	62 hp. (Friction and windage of generators)

These values are plotted with respect to time in *Figure 8*. The average power input to the generators on the duty cycle is found as follows:

½ (1,318 hp.+3,290 hp.) 1.8 sec.=	4,160 hp. sec.
½ (3,290 hp.+7,330 hp.) 3.2 sec.=	17,000 hp. sec.
½ (2,494 hp.+5,414 hp.) 2.85 sec.=	11,300 hp. sec.
½ (2,440 hp.+3,670 hp.) 2.85 sec.=	4,350 hp. sec.
½ (4,260 hp.+4,240 hp.) 0.3 sec.=	1,275 hp. sec.
½ (374 hp.+ 120 hp.) 3 sec.=	725 hp. sec.
(62 hp.) 9 sec.=	560 hp. sec.
	39,370 hp. sec.
—½ (2,700 hp.+395 hp.) 3 sec. =	—4,650 hp. sec.
Total net input to generators =	34,720 hp. sec.

$$\text{Average power input to generators} = \frac{34{,}720 \text{ hp. sec.}}{26 \text{ sec.}} = 1{,}335 \text{ hp.}$$

The average input to the generators is shown in *Figure 8* as a horizontal line at 1,335 hp. The shaded area above this line represents the energy which must be delivered by the flywheel for total equalization. This area is found as follows:

½ (7,330 hp.—1,335 hp.) 5 sec.=	15,000 hp. sec.
½ (2,494 hp.+5,440 hp.)—1,335 hp. 2.85 sec.=	7,500 hp. sec.
½ (2,440 hp.+3,670 hp.)—1,335 hp. 2.85 sec.=	4,900 hp. sec.
½ (4,260 hp.+4,240 hp.)—1,335 hp. 0.3 sec.=	875 hp. sec.
Output of flywheel on cycle=	28,275 hp. sec.

A flywheel motor generator set using two 1600-Kw. generators as required by this service would have an economic synchronous speed of 600 r.p.m. when driven by a 60-cycle motor. The automatic slip regulator used with the flywheel set will cause a permanent slip of about 3 percent in addition to the normal slip of 2 percent on the induction motor so that the full load speed of the motor generator set will be 0.95 × 600 r.p.m. = 570 r.p.m.

The flywheel used with this set would be constructed of steel plates capable of operating at a peripheral speed of 2,400 ft. per min., with ample factor of safety. The wheel diameter will accordingly be 12 ft. for the set under consideration.

The radius of gyration of a wheel of this construction is 0.707 times the outside radius and the speed at the radius of gyration at 570 r.p.m. is:

$$V_1 = \frac{570 \times 2\pi \times 0.707 \times 6 \text{ ft.}}{60} = 253 \text{ ft. per sec.}$$

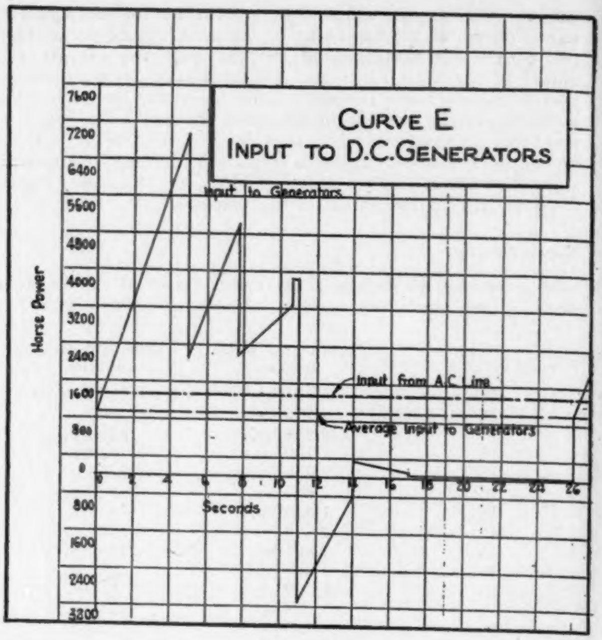


Figure 8

On hoisting service such as this where a comparatively light flywheel can be used it is the practice to allow a decrease of 10 percent in the speed of the set. The low speed accordingly would be:

$$V_2 = 0.9 \times 253 \text{ ft. per sec.} = 237 \text{ ft. per sec.}$$

The weight of flywheel is found from the following formula, which is based on the fundamental law of mechanics that energy stored in a moving mass is equal to ½ MV^2:

$$\text{Wt. Flywheel} = \frac{\text{Hp. sec. output} \times 550 \times 64.4}{V_1^2 - V_2^2} \quad \text{Pounds}$$

$$\text{Wt. Flywheel} = \frac{28{,}275 \text{ hp. sec.} \times 550 \times 64.4}{(253)^2 - (237)^2}$$

Wt. Flywheel = 80,000 lbs.

Induction Motor:

The rating of induction motor to drive the flywheel MG set is found by adding separate losses to the average input to the generators, as follows:

Average input to generators	=	1,335 hp.
Flywheel loss	=	60 hp.
Slip regulator loss	=	130 hp.
Excitation	=	40 hp.
Total load on induction motor	=	1,565 hp.

$$\text{Input from line} = \frac{\text{Motor output}}{\text{Motor efficiency}} = \frac{1{,}565 \text{ hp.}}{0.92} = 1{,}700 \text{ hp.}$$

It is good practice to allow a margin of at least 10 percent in the rating of the induction motor to allow for lead adjustment of the regulator equipment and for possible increase in duty in the future.

Summary:

To summarize, the ratings which would be applied to this service are:

Hoist Motors, 2 1600-hp. (force-ventilated) 73.5 r.p.m.

Generators, 2 1600-kw., 570-514 r.p.m.

Flywheel, 80,000 lb., 12 ft. diameter.

Induction Motor, 1 1700-hp., 2200 volt, 3 phase, 60 cycles, 12 pole.

SHOVEL CONTROL

Variable voltage control susceptible of wide application—Motor and generator separately excited—125 volts for constant-voltage excitation—Simplicity, flexibility, complete control, ease of adjustment, smooth application and relability attained

By DAVID STOETZEL *

THE system of control used on modern large and medium size electric shovels is special and quite different from anything used in general industrial applications. Undoubtedly there are possibilities for a more general use of this type of equipment and probably there are certain problems of control which can be best worked out along the lines followed in shovel practice.

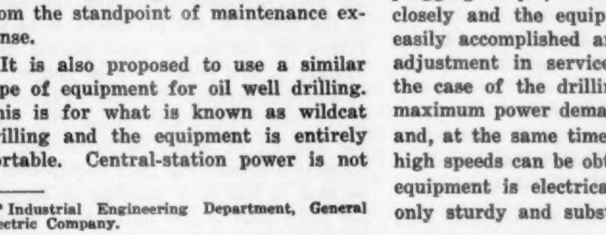
For example: There is now in operation at the plant of the Chile Copper Company, in South America, an ore bridge using shovel type control. The reports regarding the performance of this equipment are rather meager, but the indications are that it is giving very good satisfaction, both from the standpoint of operating characteristics and from the standpoint of maintenance expense.

It is also proposed to use a similar type of equipment for oil well drilling. This is for what is known as wildcat drilling and the equipment is entirely portable. Central-station power is not usually available for this work and, consequently, the primary power source is a gas engine, which has a limited output. Here the characteristics of the variable-voltage (Ward Leonard) type control permits a definite limiting of the maximum power demand to the capacity of the engine. At the same time, a type of equipment is secured which is exceptionally sturdy and reliable and not likely to break from rough handling.

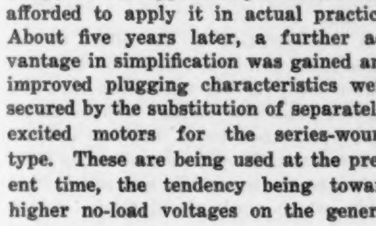
These two cases represent some of the more definite advantages of variable-voltage shovel type control for applications other than to shovels. First, as in the case of the ore bridge, there is complete control of the speed torque characteristics of the various motions involved. Lowering and hoisting speeds, as well as plugging torque, can be calculated very closely and the equipment provides an easily accomplished and wide range of adjustment in service. Second, as in the case of the drilling equipment, the maximum power demand can be limited, and, at the same time heavy torques or high speeds can be obtained. Third, the equipment is electrically simplified and only sturdy and substantial mechanical parts are used so that unusual and severe operating conditions are easily met.

Variable-voltage control for shovels is not new. Neither is it very old. Until about 1920 rheostatic control equipment very similar to that used for steel-mill auxiliaries was used. This was fairly successful but did not fully meet the ideals for shovel service in the way of speed torque characteristics and strength of the equipment. About 1920 the variable generator voltage or Ward-Leonard systems of control, using differential compound wound generators and series type mill motors, was adopted by General Electric. This system had been outlined and engineering development worked out two or three years previously, but an opportunity had not been afforded to apply it in actual practice. About five years later, a further advantage in simplification was gained and improved plugging characteristics were secured by the substitution of separately-excited motors for the series-wound type. These are being used at the present time, the tendency being toward higher no-load voltages on the genera-

* Industrial Engineering Department, General Electric Company.



Left—Speed torque characteristics of shovel equipment. MDS separately excited motor, Ward-Leonard control. Dotted line shows characteristic for MDS 418 motor with larger generator. Dash line shows characteristic of steam engine



Right—Elementary connections of shovel equipment, separately excited motor, Ward-Leonard control

tors, higher maximum speeds on the motors, and sustained torque during acceleration and moderately high speeds.

The variable voltage system of control as applied to shovels is not difficult to understand. In its elementary form it consists of a generator having its armature solidly connected to the armature of a motor. Both the motor and the generator are separately excited. In addition, the generator has a self-excited field supplying a fairly large part of its total maximum excitation. The generator also has a third field winding which is the differential series field winding, and which is the outstanding characteristic of the variable voltage shovel-type control. It will be readily understood that each motor or group of motors on the same load must have its own individual generator and that the complete equipment must include a reliable source of constant-voltage excitation, usually 125 volts. In order to reverse the motion, it is only necessary to reverse the separately-excited field of the generator. This reverses the generator voltage and the action of the self-excited and differential series fields of the generator accordingly reverse also. A suitable resistor with a drum controller for cutting out steps gives control of the generator separately-excited field strength. Additional contacts on the controller also provide for reversing the field.

A consideration of the effect of the three fields mentioned above on the generator leads to the conclusion that the highest generator voltage will be at no load or, in other words, when no current is flowing in the differential series field, and when the separately and self-excited fields, which work cumulatively, are at their maximum. In practice, a no-load voltage of somewhere around 400 volts is obtained on equipment which has a nominal rating of 250 volts; i. e., where standard 250-volt mill motors are used. As load is put on the motor, it draws more and more current and this increases the effect of the differential series field until a point is reached where the effect of the differential series field is practically sufficient to overcome the ampere turns of the separately-excited field. The self-excited field will vary its strength according to the terminal voltage of the generator. At last a stalling or maximum current condition is reached where the voltage is only sufficient to overcome the IR drop of the circuit and the current is maximum. Intermediate points between the points of maximum voltage and maximum current will be found to lie along a bow-shaped curve. The shape of this curve can be readily changed by changing the proportions of the generator field. Similarly shaped curves starting at lesser points of maximum voltage and ending at lower values of maximum current will be found for the successive separately-excited generator field strengths as produced by the various points on the control resistor.

Since the field of the motor remains constant and since, under such a condition, the motor torque will be very closely proportional to the armature current and the speed will be proportional to the impressed voltage, it is found that there are also, for the various controller points, a family of torque curves in general the same as the volt-ampere curve of the generator. It is this group of speed-torque curves in which one is primarily interested in designing a given equipment. The maximum speed and the maximum torque, as well as the intermediate values, can be definitely determined and designed for.

In actual practice, on shovels, there are three generators, one for each motion of the machine, all driven by a single synchronous or induction motor. This arrangement can be varied, of course, to suit any type of machine under consideration. In some cases, only one generator will be required, while in others perhaps as many as five or six will be necessary.

The outstanding features of an equipment of this kind are:

1. Simplicity.
2. Flexibility.
3. Complete control of speed-torque characteristics and maximum power used.
4. Ease of adjustment.
5. Smooth application of power and smooth plugging characteristics.
6. Sturdiness and reliability.

The only limitations are a rather high first cost and the necessity for additional space for the motor-generator set.

DISSOLUTION OF OXIDIZED COPPER MINERALS

The results of experiments in the dissolution of various oxidized copper minerals are outlined in Serial 2934, recently issued by the Bureau of Mines. The paper is one of a series being prepared by the Southwest Experiment Station of the bureau in cooperation with the Department of Mining Metallurgy, University of Arizona, Tucson, Ariz., dealing with factors involved in the leaching of copper ores.

A knowledge of the time required to dissolve the various copper minerals present in ores, as well as of the consumption of leaching reagents, is very desirable, because with the decrease of the Nation's total tonnage of sulphide ores increasing attention is being given to the recovery of copper by leaching methods from low-grade disseminated ore containing both oxidized and sulphide minerals, points out John D. Sullivan, the author. As leaching has already been applied with success and profit, this study was undertaken to determine certain fundamental characteristics that are applicable to all ores suitable for leaching. Preceding articles have dealt with the ingress of leaching solutions into rocks and the removal of soluble copper from leached ores.

Results on one sample of azurite, one of malachite, one of tenorite, and five of chrysocolla are reported in the present paper.

WHERE THE QUICKSILVER GOES

In order to obtain comprehensive information on the amounts of quicksilver used by various industries, so that some estimate for future needs might be made available, an economic survey of the quicksilver industry is being conducted by the Pacific Experiment Station of the U. S. Bureau of Mines in cooperation with the University of California, Berkeley, Calif.

Unlike many metals, quicksilver is often sold directly by the producer to the consumer, and thus the distribution of consumption of the metal is of extraordinary interest to the producer. In the past, economic conditions and doubt in the minds of the producers as to the future of the metal have caused production in this country to be subject to violent fluctuations. Consumers of quicksilver have cooperated generously with the Bureau of Mines in furnishing information concerning their requirements, so that it has been possible to account for more than 30,000 flasks used during the past year, giving the first reliable data concerning the channels of consumption of the metal in this country. The present market value of this material in the unrefined form would be between $3,500,000 and $4,000,000. Various individuals have estimated a domestic consumption of from 32,000 to 35,000 flasks.

One of the surprising factors disclosed by the survey is the relatively large proportion of quicksilver used for scientific and technical instruments. The declining and soon nearly negligible consumption of quicksilver for amalgamation processes of recovering gold was formerly a large use, but has been more than outdistanced by the use for scientific and technical instruments. Modern industry has turned more and more to scientific and often automatic control methods in its processes, and because mercury is a liquid metal at ordinary temperatures it has here a unique field of usefulness. To have faith in the future of modern industry is to have confidence in the future of quicksilver.

MECHANIZATION REPORT No. 29-1.

Comparison *of* Mining Plans *Modified for* Mechanized Loading

By G. B. SOUTHWARD

THIS article describes a number of mining plans which are being operated with some form of mechanized loading and shows several typical designs which represent the more usual modifications which have been made from the hand mining systems. These plans illustrate gradual and successive changes from room-and-pillar to long faces and their range includes operations with all types of loading equipment. A study of these designs gives a fairly comprehensive idea of the adaptability of mechanized loading to the standard mining systems and will also permit a rough comparison between the comparative merits of the different methods shown.

At first thought it may appear that there can be no direct comparisons between a system designed for heavy cover and one designed for light cover or for a hard sandstone roof and a soft shale. It may also seem that there is no comparable basis between a mining system designed to work a lease which specifies a high coal recovery and one where the lease requires sufficient coal left in place to prevent surface damage or subsidence. This, however, is not quite true. During a long period of years with hand mining the room-and-pillar method and the longwall system have together shown themselves capable of meeting practically every physical condition which has been encountered, and comparisons can be made between modifications of these standard plans which have been made without involving any new principles of design.

However, a properly designed mining system must fulfill two general requirements; it must successfully meet the underground physical conditions and must conform to the operation of the equipment which is used. In the adoption of mechanized loading the operation of the machines is altogether different from hand work, so that our immediate need and interest is to determine to what extent the mining plan affects this operation.

Coal loading may be roughly divided into three phases; the first being the face preparatory work of breaking down the coal, the second is the loading which includes gathering or transporting the coal away from the working face, and a third is the dead work which includes timbering, track and slate handling. Each of these phases, as noted, has several operations and if we list them in the following order of (1) Cutting, (2) Drilling, (3) Shooting, (4) Loading and Gathering, and (5) Dead Work, we see that there are at least five distinct operations, all of which must be performed at separate times and all must be performed during each complete operating cycle whether the work is carried on one, two, or three shifts.

In this performance the loading rate sets the pace and the mining system should be designed to permit all operations to be carried on during the cycle without interference. This result is brought about in two ways; one by having a limited number of working places under development with a proper scheduling of the work and the other is by having an extensive number of working places so as to obviate the necessity for any particularly rigid or balanced schedule. The first of these methods concentrates the workings and, in principle, is the better design, as a certain degree of concentration reduces the unproductive work necessary for moving the machines as well as reduces the amount and the cost of track work, timbering, mine maintenance and supplies. The mining plan also governs the track and switching, which has a direct reflection on the gathering efficiency and in general it is true that the systemization of the entire mining operation, on which the mining cost directly depends, is governed to a large extent by the number, arrangement and the location of the working places.

It is probable that any very radical changes in the mining systems will be made gradually, and it is highly desirable that this should be so. We have not yet determined exactly what all the requirements of mechanized loading are, and our present need is to study these and let the development of the mining plans be governed by our knowledge and experience as it is gained rather than by theory which has not been proved. The present article therefore will deal only with mining systems that are in actual operation and will endeavor to show how these are meeting the requirements of mechanized loading.

Figures 1 to 5 show five different sketches based on mining plans which are operating under a fairly wide range of seam conditions. For the purpose of comparison it is assumed in these sketches that all are in the same height of coal and that all are producing the same daily tonnage. These assumptions do not place the comparisons on a theoretical basis, as the methods of operation outlined with each plan are those in actual use and the number of places assumed to be loaded out is based on actual practice.

Figure 1 shows the standard room-and-pillar system in which practically no departure has been made from the hand mining plan except that a considerable degree of concentration has been effected. This plan is largely confined to operations with loading machines and pit car loaders. In this system it is assumed that six rooms are ordinarily cleaned up during the working shift and that all the other operations except the shooting are worked on the same shift with the loading and that the shooting is done at night or at the end of the working shift. Since there are nine rooms under development this plan provides at least three working places in which the other operations besides the loading can be started at the beginning of the shift. With this amount of leeway the other operations can then continue during the shift without interruption, working behind the loading machine in the rooms which have been loaded out and by the end of the shift the work can be properly scheduled so that there will be at least six places timbered, cut, drilled, and ready for the night shooting and the next day's loading.

Figure 2 shows the standard room-and-pillar system with mechanical loaders as in *Figure 1*, except that the territory under development is limited to the number of rooms which can be loaded out during the day shift. This plan may be operated with the shooting either on the day shift or at night. Where day shooting is not permitted all room faces must be shot down and made ready for loading at the beginning

Figure 1 shows a standard room and pillar panel which is worked as an operating unit with mechanized loading. Six rooms are assumed to be loaded out each day and nine rooms are kept under development to have places for cutting, drilling, etc., during the day shift. In order to provide additional territory as the rooms are worked out each heading must advance at the rate of two-thirds cut per day. The rooms are shown 25 ft. wide and assuming the seam is 7 ft. high with a 7-ft. undercut the daily production from this panel would be approximately 300 tons.

FIGURE 1

NINE ROOMS ADVANCING

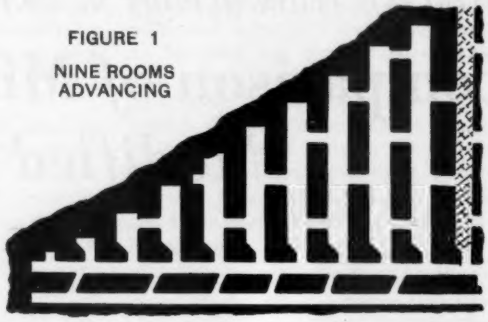


Figure 2 shows a room and pillar panel which is worked as an operating unit with mechanized loading. Six rooms are assumed to be loaded out each day and the territory under development is confined to this number of working places. The cutting, drilling, etc., may be performed on either shift, but where no shooting is permitted during the day time these operations are usually done at night. In order to provide additional territory as the rooms are worked out each heading must advance at the rate of one cut per day. The rooms are shown 25 ft. wide and assuming a seam 7 ft. high with a 7-ft. undercut the daily production from this panel would be approximately 300 tons.

FIGURE 2

SIX ROOMS ADVANCING

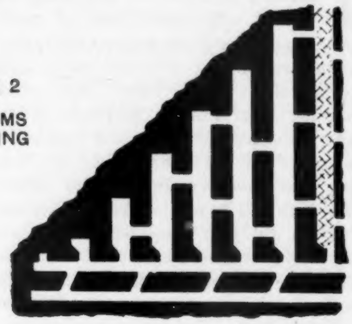


Figure 3 shows a room and pillar panel with the cross cuts so spaced that as soon as one is driven through the next one is ready to be started. This always provides two working faces in each room. The cutting, drilling, etc., may be performed on either shift, but where no shooting is permitted during the day time these operations are usually done at night. In order to provide additional territory as the rooms are worked out each heading must advance at the rate of one cut per day. The four rooms under development as shown are 25 ft. wide with 18-ft. breakthroughs and this territory will produce a tonnage equivalent to that mined from the six rooms in Figures 1 and 2.

FIGURE 3

FOUR ROOMS ADVANCING

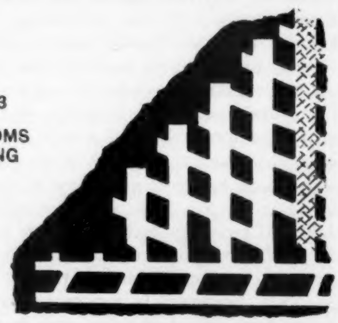


Figure 4 shows a room and pillar method where the room width is increased above the usual standards and where more than one cut is loaded from each working place during a shift. With this system all the operations are performed on the same shift with the cutting, etc., in one room and the loading in the other. This method can be used only where the coal can be shot down during the day. In the sketch the rooms are shown 40 ft. wide which assumes that two cuts must be loaded in each place during the shift to produce a tonnage equivalent to that mined from six rooms at 25 ft. wide as in Figures 1 and 2. The entry development must advance at the rate of one cut per day in each heading.

FIGURE 4

TWO ROOMS ADVANCING

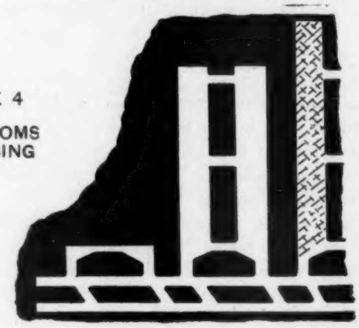
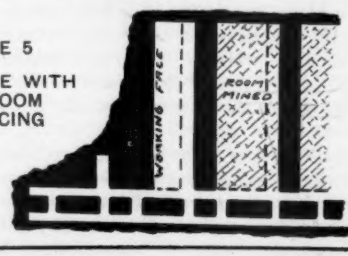


Figure 5 shows the room and pillar system modified into long face mining. The room is driven to the required length and is then widened by long face slabs until an area has been mined where the roof can not be held on the timber supports. When this width is reached the area is abandoned and a new room is started. With this system the preparatory work may follow behind the loading on the same shift or may be done entirely at night. In either case a slab 150 ft. long loaded out each day will produce the same tonnage as mined from the six rooms in Figures 1 and 2, and with this length of face the entries and the narrow room must each advance at the rate of one cut per day.

FIGURE 5

LONG FACE WITH ONE ROOM ADVANCING



of the shift, and in such cases this plan necessitates double shifting with the cutting, drilling and dead work at night. This schedule is sometimes modified by starting the second shift two or four hours after the loading shift is begun when there are one or two rooms cleaned up and ready to be cut. With proper scheduling all operations can then follow behind the loading and the preparatory and dead work should be completed within eight hours from their starting time.

Figure 3 shows a slight modification from the standard method as developed for mechanical loaders by which a larger percentage of coal is mined from the cross cuts. These are so spaced and driven that each room always provides two working places. With this plan the usual method is to have breakthroughs about two-thirds of the room width so that the four rooms under development as shown provides the equivalent of slightly more than six room faces. Where day shooting is not permitted this plan necessitates some double shifting for the preparatory and dead work as it is necessary to have practically all of these working places shot down and ready for loading at the beginning of the day shift. The same schedule as is described in *Figure 2* is sometimes followed by starting the second shift two or four hours after the loading shift is begun. This plan of providing two working places in each room increases the concentration and reduces the amount of travel by the machines. Two operations, such as cutting and drilling, can usually be performed at the same time in a single room which is approaching group working and allows a certain amount of exchange of labor between two crews.

Figure 4 shows a further modification of the standard room-and-pillar method in which the fundamental principle of the room-and-pillar mining is retained in the arrangement of the working places but a distinct departure is made in the operation. This plan is used quite extensively with conveyor operations. In this method the width of the rooms are increased about 50 percent and only two rooms are worked at one time. This means that it is necessary to clean up each room twice during the loading shift in order to produce an equivalent tonnage to that which would be mined from six rooms at 25 ft. wide and requires that all operations, including the shooting, be carried on during loading shifts. The usual working schedule in this plan is to have the preparatory and dead work carried on in one room while the loading is being done in the other. In such cases instead of having a separate crew for each of the mining operations it is customary to divide the work between two crews—the loading crew and the preparatory crew.

The width of the working face is such that usually two operations can be carried on continuously. For instance, cutting and drilling can be worked together, and frequently the loading will start at one corner of the room and work across the face with the cutting or the timbering following immediately behind. In this plan it has been found rather difficult to arrange the work so as to keep the loading going on continuously at all times during the shift as some interruptions and interferences will occur. However, there are mines where this system is used that are averaging more than two clean ups per day in each room.

Figure 5 shows the room-and-pillar method modified into long face mining and represents a type of mining operated by mechanical loaders, conveyors and scrapers. In this system a narrow room is driven and then widened by slab cuts until its width has increased to a point where the roof can no longer be supported on timbers. When this is reached a new room is started, leaving a sufficient pillar next to the mined area to break the top and prevent the weight from carrying over. This method is used with mechanical loaders, scrapers and conveyors. In one or two cases where this plan is used all work is done continuously on the day shift with the cutting and other operations following directly behind the loading. With such a schedule it is not necessary to fix a time limit on the performance of any of the operations and a portion of a face or more than a face cut can be loaded out during the shift. It is more usual, however, to divide the work into two shifts with only the loading in the day time and with the preparatory and dead work at night. In most cases it is customary not to have men confined to any particular operation, and after a face is cut the same men will do the drilling or help with the timbering, track work and move the conveyors, where conveyor mining is employed.

LEGISLATIVE REVIEW

(From page 596)

$5 on the sale of each share of stock of a face value of $100 or of no face value. Finance.

S. 669. This bill authorizes the Government to enter suit to adjust the land grant to the Northern Pacific Railroad, which involves the classification of mineral land. Enacted into Law.

S. 1574. Mr. Norris (Rep., Nebr.). This bill proposes regulations to secure safe working conditions on board vessels for those employed in loading and unloading cargo. Commerce.

S. J. Res. 64. Mr. Gillet (Rep., Mass.). This resolution directs the Interstate Commerce Commission and Shipping Board to investigate and report on July 1, 1930, as to the practicability of equalizing rail and ocean rates on export and import traffic between the United States and foreign countries. Commerce.

S. 104. Mr. Walsh (Dem., Mont.). This bill appropriates $1,943,200 to construct a highway from Red Lodge to the boundary of Yellowstone National Park near Cooke City, Mont., which would benefit the mining industry by affording better means of transportation. Transferred from the Post Offices to the Public Lands Committee.

H. R. 1. This bill proposes to place agriculture on a basis of economic equality with other industries by promoting the effective merchandising of agricultural commodities in interstate and foreign commerce. The act is to be administered by a Federal Farm Board of nine members, which will seek to minimize speculation and prevent inefficient and wasteful methods of distribution of agricultural and food products. Loans to a total of $500,000,000 to agricultural cooperative organizations are authorized. Of this amount Congress has appropriated $150,000,000 and in addition $1,500,000 for expenses of the board and members of advisory commodity committees which are authorized to assist the board. The board is to investigate transportation conditions and their effect upon the marketing of agricultural commodities; land utilization for agricultural purposes and prevention of over-production. Enacted into law.

H. R. 4076. Mr. Watres (Rep., Pa.). This bill amends the smoke prohibition law of the District of Columbia by applying the act of 1899 forbidding the discharge of smoke from stationary engines, boilers or furnaces, to smoke from locomotives, steamboats, steam shovels, tractors or other movable engines, boilers or furnaces in the District of Columbia. The act would be enforced by the engineering department of the District instead of by the Health Department. The act is designed to protect the public buildings and other beauties of Washington from soot and smoke. District of Columbia.

S. Res. 83. This resolution appropriates an additional $15,000 to that previously voted, to complete the investigation of Indian Affairs by the Senate Indian Committee. Passed by the Senate.

S. Res. 37. Mr. Nye (Rep., N. Dak.). This resolution proposed to discharge the Senate Immigration Committee from consideration of S. 151 to repeal the national origin provision of the immigration law under which immigration quotas are based. The committee had voted not to report the bill and the purpose of the resolution was to bring the bill before the Senate for action. Defeated by the Senate.

PRACTICAL OPERATING MEN'S DEPARTMENT

COAL

NEWELL G. ALFORD
Editor

Practical Operating Problems of the Coal Mining Industry

Mining System

of WHEELING TOWNSHIP Coal Mining Company

Mechanization developed to yield steady employment and high wages—Production and development units created—Nine complete units operate double shift with one reserve unit—Relief association and mutual insurance plan eminently successful.

By E. J. CHRISTY *

THE No. 2 Mine of the Wheeling Township Coal Mining Company is worked with mechanical loaders.

The joint conference of representatives of employes and of management is employed. Earnings are computed by a group production method which was worked up as a part of the mechanical program in operating the mine.

The property is located in Harrison County in Eastern Ohio, about seven miles from Cadiz on the A. C. and N. A. branch of the Wheeling & Lake Erie Railway Company. The mine is a drift in the No. 8 seam, with an average covering of about 100 ft.

The seam is very uniform in thickness, varying from 4½ to 5 ft. Of fairly hard structure, with a regular parting near the center of the seam which makes shooting slightly difficult, 12 in. of draw slate which has to be put back or loaded. The roof is very tender, requiring systematic timbering. Open lights are used and the mine contains enough moisture as not to require rock dusting.

The mine was purchased in 1919 and all coal was being cut by shortwall machines, hand loading, mule gathering on room entries, motor gathering and haulage from butt entries to tipple. The inside haulage tracks were 40-lb. rail, 42-in. gauge, and the mine cars were about 2-ton capacity.

The tipple had gravity screens with no preparation before reaching the crusher, where it is reduced to a product ¾ in. and smaller.

* Consulting engineer, Wheeling Township Coal Mining Company, Adena, Ohio.

Operation continued in the same manner until September, 1924, when serious consideration was given to mechanical loading by the management of our company.

MECHANICAL LOADING

The first of June, 1925, one 5-BU Joy loader was started in a section of the mine which had been developed by hand loading, but prepared for mechanical loading by replacing light 16-lb. rail with 25-lb. rail, purchased 3½-ton steel roller bearing cars to serve the loader, and one 3½-ton cable reel gathering motor was used to replace the mule haulage in serving the loading machine with cars and delivering loaded cars to a passway on the butt entry at a point where the haulage motor placed empty cars. Goodman and Jeffrey shortwall machines are used in cutting the coal and Chicago pneumatic (Little Giant) electric drill is used for drilling.

PLAN OF MINING

The room and pillar plan of mining is in use, although considerable experimenting has been done, such as various width of rooms, different track systems to speed transportation in serving the loader, different ventilating methods, drilling, shooting and explosives. All the work was done at the union day rate prevailing for the various classes of labor performed, and a daily time study made of this mechanical operation from June, 1925, to January, 1927. January 1, 1927, the second unit, one 5-BU Joy loader, one 4-ton cable reel Jeffrey gathering motor, forty-eight 3½-ton steel mine cars equipped with Timken bearings, one shortwall cutting machine, and one electric drill.

The mechanical loading experiment was continued with the two units from January, 1927, to April, 1927, when the mine ceased operation on account of the union contract expiring.

In April, 1927, the management of our company decided there should be a way in which the mine could be operated without the periodical shutdowns.

The experience, records, and time studies on the mechanical loaders was carefully analyzed and a conclusion that the only way possible was a mechanical operation, steady employment, pay to its employes the highest possible wage, and institute and maintain a system whereby individual effort will receive compensation in proportion to the effort expended.

NEW METHODS

A wage plan was worked out for development, production and day rate, all development to be done by development units consisting of one loading machine, one cutting machine, one locomotive, and one electric drill. A development unit has a group of nine men, composed of loading machine operator and helper, one cutting machine operator and helper, who do all drilling for shooting, one motorman and triprider, one tracklayer, one shotfirer, and one stone man.

A production unit is to have the same equipment as a development unit, but has a group of 12 men, loading machine operator and helper, cutting machine operator and helper, who do all drilling for shooting, motorman and triprider,

tracklayer, timberman, shotfirer, and three stone men.

The development units work in all heading entries and room entries until only five room necks have been turned.

The production units work in room entries only, starting with the five rooms, which were developed, and carries the development of the room entry to the distance required.

Wage Payment on Unit Plan

The nine men on a development unit are paid on the basis of their output, and likewise the 12 men on the production units.

The units are divided into four classifications — loading machine operator, loading machine helper, cutter and driller; other men on the units are classed as helpers. Each man has his base rate, which determines his percentage participation in the earnings of the group. A daily tonnage quota is set for both development and production units, and the output of the loading machine measures the production of each group.

Complete Mechanization

In June, 1927, it was decided by the management to carry through the program and put in equipment for the complete mechanization of the mine.

June 1, 1927, we purchased eight 5-BU Joy loaders, eight 4-ton cable reel Jeffrey gathering motors, eight (Little Giant) Chicago pneumatic electric drills, and 141 3½-ton steel mine cars, Timken roller bearing equipped. The shortwall machines we had in use in hand mining were to be used for cutting the coal.

This made a total of 10 complete units, nine of which were to be put into service double shift and one complete unit in reserve as a spare to prevent lost time from breakdowns that would take extensive repairs.

The plan outlined, the wage schedule and working conditions were brought to the attention of the former employes.

The Working Conditions

The mine would work independent as it was desired to operate two shifts each day, 8 hours per shift, 5½ shifts per week. Day shift starts at 8 a. m. and ends at 4.30 p. m. Night shift starts at 5 p. m. and ends at 1.30 a. m., except Saturday the day shift ends at 12 m. and the night shift starts at 12.30 p. m. and ends at 4.30 p. m. This means two separate complete shifts are maintained on the inside and outside of the mine, and none but former employes would be employed in starting the mine.

In July, 1927, we had sufficient of our former employes who had come voluntarily and signified their approval of the plan as outlined and were ready to go to work.

Preparations were made for operation on August 1, but at 12.30 a. m., August 1, our tipple was destroyed by fire, and it was the middle of February, 1928, when a new steel tipple had been completed, equipped with modern methods of screening, conveying, picking, and crushing the coal.

March 1, 1928, the first mechanical unit was started, which was composed of practically the same crew that was on the loading machine when operation ceased March, 1927.

The second unit was started with a part of the crew who had some experience on the mechanical loader. April 8 the third crew was added, all inexperienced in mechanical mining, and, therefore, an educational program had to be carried on as additional units were added, until by June 15 the nine units were operating double shift.

The day production units working room entries have five rooms and one entry and work in a cycle, developing the entry and rooms to the full distance of the room entry. The night production units work the room entry paralleling the day shift, using the same equipment.

The development units in many cases double shift in the same entries, using the same equipment for both shifts.

Cutting and Drilling

Cutting and drilling are both done by the cutting machine operators, who carry the drill on their machine, drill both coal and stone holes before moving their machine from the face of the working place, drilling four holes in the coal and three holes in the draw slate.

Shooting Coal and Stone

A shotfirer on each unit cleans out all cuttings from under the cut, charges and tamps all coal holes, firing only the snubbing and center shot until loading machine has loaded out the middle of the cut, when the ribs are shot.

Unit Transportation

The loaders on each unit are served by a motor and 27 mine cars in service for each production unit, and 16 mine cars in service for each development unit.

Main Haulage Transportation

In preparing for mechanical operation, a local dip was brushed for a distance of 1,400 ft. to a height of 9 ft., which changed the grade from 2½ percent to one-half of 1 percent grade, and gunnited the entire length. All 40-lb. track was removed and 60-lb. track laid on haulage road from inside of the mine to the tipple on the outside.

Two haulage motors, 15-ton Jeffrey armor-plate type, are used in transportation on main haulage. One 13-ton locomotive as a spare is in reserve, in case extensive repairs would have to be made to a haulage motor; 212 mine cars are used in the transportation service.

All motors, cars, supplies, and mechanics from the outside to the face of the unit workings are handled by a dispatcher, located in an office on the outside of the mine.

Efficiency Engineer

In order to increase the efficiency of our loading machines and also of our entire mine, an experienced efficiency engineer was employed. The major part of his duties is to obtain accurate time studies on all operations and on all delays. After a thorough time study analysis has been made on each unit, steps are taken to correct any inefficiencies on this unit.

Coal Analysis

Analysis of our coal plainly showed that surface cleaning would be needed for mechanical loading. Under hand loading no surface cleaning was employed. Six pickers were placed on each shift, but even with this number of pickers the results were not satisfactory. It was decided that a closer check must be maintained on our product in order to obtain cleaner coal.

From time to time samples were sent to a commercial laboratory for analysis. This method would, of course, give the desired information, but as it required from two to three weeks to secure the analysis, the information did not tell what we were doing at present. In order to secure this information, a chemical laboratory was installed. It consists of an up-to-date laboratory for making coal analysis.

Samples are now taken at regular intervals, and in between if needed. This gives a very close check and conveys to the supervision what the coal analysis is now and not what it was two weeks ago. This may seem at first an investment that will not pay for itself, but the results obtained proved otherwise. It lowered the ash content about 2 percent, and also showed, by a little experimenting, that the most efficient number of pickers to employ per shift was four, instead of six. We attribute all of this to the fact that this method gave a closer check on our product and that the men know a close check is being maintained on their work.

The Joint Conference of Representatives of Employes

The mining operation is divided into six departments, as follows: Loading machine operators, loading machine helpers, cutters and drillers, transportation, maintenance, and outside employes.

The employes select their representatives for the various departments by a secret ballot at an election held each six months. There being two representatives elected at each election, the two retiring representatives being the two who received the third lowest percentage of votes in the previous election.

The management selects six representatives. Meetings of employes and management representatives are held on the first Monday of each month to take up questions that come up in the various departments during the period, or if matters of importance need attention a special meeting is called.

This plan has been in operation for 14 months and has worked to the satisfaction of both employer and employe.

Employes Relief Association and Insurance Plan

Each employe on being hired is interviewed in regards to joining our Employes' Relief Association and Insurance Plan. He is not compelled to join, but after the plan is thoroughly explained, he joins very readily.

The plan, as explained to each employe, is as follows: By joining the Employes' Relief Association, for which the premium is $0.70 per month, he receives the following benefits. First, the company takes out and pays all premiums on a $500 life insurance policy as long as the employe keeps up his premium in the relief association. This policy is paid in full to his beneficiaries at his death, whether by natural or unnatural causes, while at work or otherwise. Second, he shall receive $10 per week after the first full week of disability for a period of 13 weeks in any one year for any sickness or accident that is not covered by state compensation. So far our record is 100 percent for this plan.

Scraper Loading

at SCRANTON COAL COMPANY

Four chambers constitute one unit for scraper loading—Equipment standardized and periodically inspected — Mechanical loading effects greater savings than mechanical cutting—Each carload tested for lump coal, fines and refuse

By E. W. LAMB*

THE Scranton Coal Company operating in the Northern anthracite field has been using the scraper type mechanical loader for chamber mining nine years. Installations of the scraper type have been on the increase each year, and have now been used in a very wide range of conditions of first and second mining.

The early mechanical loading installations made by this company, as with many others in the same field, were in sections of prohibitive hand loading cost. As a result the early installations were often working under great handicaps as to physical conditions of the bed, haulage and inexperienced labor. During this experimental period with many different conditions to meet, as in all anthracite mining, it necessarily followed that many different methods were used to meet these conditions, but it was soon determined that all beds are not suitable for mechanical loading, due in a measure to the fact that when first laying out the plan of operation the possibilities of mechanical loading were not taken into consideration.

During the past five years sections of various beds are set aside for scraper mechanical loading, and in doing so the plan of mining, transportation and ventilation all function to keep the loading units operating efficiently. Some comparative figures will be given of various units in beds of different thickness and character, but the paper will discuss chiefly scraper loading for a complete cycle of mining and the results obtained as compared to similar work with the "car chamber" system of hand loading.

In general it is necessary to restrict the plan of mining to the room-and-pillar system. Final robbing in overlaying beds is still in progress. Such being the case an intervening period of two or more years is between the time of first and second mining, which eventually is a big factor in the difference in cost of scraper

*Assistant general superintendent, Scranton Coal Company, Scranton, Pa.

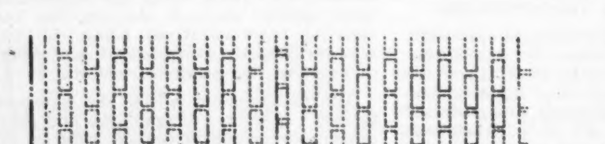


Figure 1

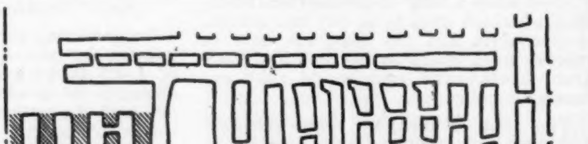


Figure 2

and hand loading. The added cost of relaying track for hand loading is the largest item in sections such as described above.

Figures 1 and 2 show typical sections being worked with scraper loaders. They were selected because of similar conditions and were used in making comparisons. *Figure 1* shows actual mining and the projected plan of a bed that averages 30 in., having a bone content of 3 in. at intervals. The roof and bottom is sandstone, with irregular surface adjacent to the coal. The bed is practically flat with an average cover of 150 ft. and is nongaseous. Headings and airways advanced by hand methods, driven 12 ft. wide in bottom rock and 20 ft. wide in the coal. Six ft. clearance over the rail is carried in all headings and airways. Chambers are on 54-ft. centers, 30-ft. chamber and 24-ft. pillar. Panels are 500 ft. in width, the chambers being advanced 250 ft. from opposite headings of the panel as illustrated. We found this to be the length chamber best adapted to scraper loading. Four chambers are considered as a complete unit for each scraper loader operation, more than this materially deducts from the efficiency of the unit because the men in the loading face can not manipulate the ropes and scoop to advantage. Crosscuts selected as hoist stations, as marked on plan, have a height of 5 ft. and are used so that the hoist position is reversed and used for both heading and airway chambers.

Published discussion of the scraper loader have been of sufficient number, and the installations sufficiently numerous to permit eliminating many descriptive details of mechanical operation.

Equipment has been standardized and is periodically inspected. The equipment and installation cost including all props and loading chutes for one unit, is $1,604.00. Wooden pulleys are carried on the tail rope side of each chamber, and we find it increases the life of the rope 45 percent.

Realizing the necessity of co-ordinating the process of loading and transporting coal from mechanical loaders "cross-over" branches are made at advantageous places as marked on plan. Extreme care is given to the mine tracks with locomotive haulage used for both gathering and main road work. In some instances a mule is used to branch cars at the loading unit.

Undercutting machines are only periodically employed in 30-ft. chamber work. Mechanical cutting devices were used previous to the installation of mechanical loading devices, but greater strides and economies have been made through perfecting a mechanical loading device than by introducing mechanical cutting devices. Cost records show that while "undercut" units give a decided increase in prepared coal over "solid shooting," the loss in production per producer, equipment cost with its high power and maintenance cost combines to take away all the advantage gained by improving the product. Ideal undercutting conditions are rare but where such did exist in a 36-in. bed at one of our collieries, a saving of $0.09 per ton was made over the previous "solid shooting" performance of the unit. This installation was the only one to show favorably for undercutting.

Each unit has an operating crew of nine men—one contractor, who supervises all work and helps at any lagging point of the unit; a miner and helper who drill, blast and prop the chamber; three scoopmen who keep the scoop loading to capacity in the face, set jacks and extend "scoopway;" two car toppers who top all cars, pick refuse from the coal and move the cars to and away from the chute; one engineer for the double-drum hoist.

Figure 2 illustrates "Scraper Loader" mining we have carried out under practically the same conditions as those described under *figure 1*. The work in this section included pillar robbing as marked, all coal being recovered from the pillars by scraper loader, with the exception of gangways and airway stumps which are being recovered by hand mining. In both sections the roof is of such nature as to be readily controlled, and breaks clean on prop lines or small pillars without any detrimental effect to adjoining places. It has been necessary to remove props to obtain a break at intervals in order to minimize the open area, which if large will increase the danger of losing coal and add to the dead work of the unit. Production from the units on pillar work was practically the same as when advancing in solid. With the roof conditions permitting, and it is the method used in this section, one chamber pillar is taken back to within 30 ft. of the heading, then work concentrated on the next pillar and in this way by concentrating on a single working face a better condition is kept and requires less movement of equipment. When roof conditions were not easily controlled the time honored system of keeping the robbing line of all pillars on an angle with the heading was used with a loss in production of 0.4 tons per producer.

Realizing the importance of improving the product from "scraper loader" units, "face test" on different methods of placing holes such as burden, angle and depth are continually made using explosives of varying amounts and strength. In making these tests we set up standard practices for particular sections. All tests are based upon cuts of an entire face. Each car taken from the cut is tested for lump coal, fine coal and refuse. The loading performance of the unit is compared for the different complete cuts and then the best combined practice is used. Units working beds 20 to 30 in. in making a complete cut of one face use 12 to 15 holes 8 ft. in depth. Electric exploders are used for the opening holes, electric timers in the remainder.

Our scraper loading operations have increased the production per producer per start 2.2 tons, and considering every item entering into the final cost, scraper loading has reduced our average cost 24 percent. The saving on actual labor and material cost is greater than the above figure, but deductions have been made for the greater value per ton of the hand mined product.

U. S. PRODUCES BUT SMALL PROPORTION OF WORLD OUTPUT OF FUEL BRIQUETS

Because of its abundant supplies of high-grade coal, the United States contributes but a small part of the world output of fuel briquets, says the United States Bureau of Mines, in a report just issued. The coal briquetting industry has attained its greatest development in countries where a large part of the available coal is of low-grade and is unsuitable for use in its raw state, it is pointed out. In round numbers the total world production of fuel briquets is now about 52,000,000 metric tons, of which Germany contributes about 87 percent. France and Belgium are the second and third largest producers, and their combined output is about one-seventh of the German tonnage. The quantity of briquets produced in Netherlands and Spain most closely approximates the output of plants in the United States.

In Germany the production of lignite briquets has increased 36.6 percent during the past five years. In 1928, when the production of German lignite was 166,224,159 metric tons, approximately 79,500,000 metric tons were briquetted, and the output of lignite briquets was 40,158,478 metric tons.

Replies made to a questionnaire sent out by the Bureau of Mines show that approximately 30 percent of the total raw fuel used in the making of fuel briquets in the United States in 1928 was silt from coal-washing operations at mines, 23 percent was screenings from dry preparation of larger sizes, 22 percent was fines resulting from breakage in transit, 17 percent was culm from banks at mines, and 8 percent was from other sources (Welsh anthracite, "river coal," screenings from wet preparation of larger sizes, and carbon residue from oil-gas manufacture). It is of interest that "river coal," dredged from streams which drain the Pennsylvania anthracite region, supplied all of the raw fuel for two briquet works and was used in combination with other raw coal by a third plant.

A total of 940,806 net tons of raw fuel of all kinds was briquetted in 1928; 40 percent of this amount was anthracite and semi-anthracite, 52 percent semi-bituminous and bituminous coal (including small amounts of semi-coke), and 8 percent sub-bituminous coal and carbon residue from the manufacture of oil gas. As the weight of binders added was greater than the weight of the moisture expelled there was a net gain of 6,617 tons during the process of manufacture.

There were no radical changes in binders used by briquetting plants in 1928. Asphaltic pitch was employed as a binder, either alone or in combination, by 13 out of 21 active plants. Eight producers used it exclusively, 2 used asphaltic pitch and coal-tar pitch, 1 a mixture of asphaltic pitch and patent binder, 1 asphaltic pitch and molasses residue, 1 asphaltic pitch and starch, 1 coal-tar pitch, 2 sulphite liquor, 1 sulphite cellulose, and 2 patent binders. Two plants briquetting carbon residue from oil gas required no binder.

Five of the producers using a binder, whose total output was 25,757 tons, reported that they recarbonized the briquets coming from the presses to drive off smoke from the binder.

The percentage of binder to raw fuel, by weight, ranged from less than 5 to 9 percent or more. The proportion most commonly used was 5 or 6 percent.

Further details are given in the Bureau of Mines report entitled "Fuel Briquets in 1928," by O. E. Kiessling and J. M. Corse, which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a price of 5 cents.

Mining Methods

of the CONSOLIDATION COAL COMPANY

Top coal left to protect roof—Pillars recovered by working open-end — Loading machines handle slate in day and coal in night shifts—Timbers not recovered—Middle parting mined to secure clean lump.

By L. B. ABBOTT *

IN presenting this paper on the Mining Methods of the Consolidation Coal Company, only those are taken up that apply to the Elkhorn Division. It is also believed that a detailed description of those used in mechanical mining will be of greatest interest, although other methods of major importance will be briefly described. Some of these methods are standard for all divisions of the company, while others are brought about by local conditions.

In the Elkhorn Division of The Consolidation Coal Company considerable coal has been mined by mechanical means the last three years. All operations are in the Elkhorn seam—this seam varying in height from 9½ to 4½ ft., and having two characteristics that add greatly to the difficulty and expense of mining. The first is a very tender draw slate roof, which, if exposed, will generally fall in large slabs. This is taken care of by leaving up about 12 in. of top coal, which in most cases affords sufficient protection if unbroken. The second is a fire clay parting about the middle of the seam, having a wide variation in thickness. In the territory developed, it has been found from 1 in. to 52 in. thick—the maximum thickness being on the southern boundary of the property—thinning toward the northwest, where the seam also becomes thinner.

At No. 205 Mine, in the sections where hand loading is being carried on, the middle parting is from 8 in. to 18 in. in thickness. On the south side of the mine, it gradually thickened—prospect entries showing it to be 52 in. thick. Attempts to work this section economically by hand proving unsuccessful, it was decided to use mechanical means, and 3 Myers-Whaley shovels and 2 Goodman slabbing machines were purchased for that purpose.

When mechanical loading was first started, rooms were driven from 12 ft. to 14 ft. wide, 270 ft. long on 90 ft. centers, cross-cuts being turned on a slight angle ahead, to permit more convenient handling of the equipment. Later room centers were reduced to 60 ft. which was found better for the system of mining.

Pillars are recovered by working them open end. Track is first laid across the long face and the entire face cut and cleaned, protection being provided by a row of heavy posts set close to the track on the gob side. The track is then torn up, and a row of timber set about 2 ft. from the face. As a shovel type machine is used for loading, it is necessary to attack the slab cut on the end and work across the pillar—the track being extended by short lengths of rail as loading progresses. This track is then used for cutting the next slab. No attempt is made to recover the timber.

The presence of the slate parting naturally divides the coal recovery into two operations. First the elimination of the rock parting, and second the loading of the coal. Two shifts are therefore necessary. The day shift cuts the places, drills the holes, cleans the parting, moves track, timbers, shoots the coal and makes the places ready for loading the coal which is handled by the night shift.

The first operations in the preparation of the places are the drilling and cutting. At present, hand electric drills are used, the driller preceding the cutting machine and drilling the holes in the bottom of coal and in the parting. The holes in the top bench of coal are drilled later.

Cutting is done by a Goodman Slabbing Machine equipped with a 11 ft. cutter bar. As the parting is hard, the cut is made in the coal over the parting, the kerf averaging 7½ ft. to 8 ft. in depth. Where the parting is very thick, cutting is done under the parting.

Parting holes are usually drilled in the bedding plane of parting and coal. In narrow work, 4 holes are drilled in the parting, and 3 holes in both bottom and top bench of coal. On open end faces the holes in the coal and parting are placed about 6 ft. apart. Gelobel permissible powder is used for shooting, and from 3 to 5 sticks used in the parting on narrow work, and 2 to 3½ sticks per hole on the open end faces.

On the completion of the cutting the slabbing machine retraces its route for the purpose of cleaning or raking out the parting. In the meanwhile, the Myers-Whaley machine has visited each place and cleaned up the cuttings and loose rock, in order to permit the slabbing machine to sump to the back of the cut. The parting has also been shot up.

The raking in narrow places is accomplished by sumping in and then swinging across the face with the cutter chain in operation. Usually one sweep of the cutter bar removes most of the parting, but if necessary, a second sweep is quickly made.

On open end places the machine is trammed across the face with cutter bar sumped in and chain in operation. This is very quickly completed and leaves but a small amount of slate to be trimmed down by hand. The cut is spragged by the machine men as raking progresses, final spragging, however, being done by the slate men.

The next operation is the loading out of the slate and this is also done by the Myers-Whaley machines, which are double shifted—loading slate in the day and coal at night. Practically all the slate is loaded into mine cars and taken to the outside.

The only operation left before the places are ready to have the coal shot is the thorough cleaning of the kerf, face and bottom. Particular attention is given this feature as the coal must pass rigid inspection and meet the high Elkhorn standard. With this in mind, all slate is trimmed from the kerf and the top of the bottom coal swept off. Finally, the small amount of refuse left by the loading machine is shoveled up, the face of the coal and bottom swept and the place is ready for shooting and loading.

In narrow work, three holes are usually drilled in the top and bottom benches, from 1 to 2 sticks of Gelobel being used in the top holes and from 1½ to 2 sticks in the bottom holes to bring down the coal. Both top and bottom benches are shot before loading starts.

The holes in the open end faces, spaced 6 ft. apart, have the bottom holes charged with 1½ sticks of Gelobel and the upper holes with from three-fourths to one stick. The bottom bench is shot across the entire face but the top bench is not shot until night, when it is brought down as loading progresses across the face.

Practically all the operations thus far described are handled by the day shift, leaving the coal loading for the night shift which starts at 6 p. m. In the narrow work, the loading machine attacks the coal directly from the track which is laid in the center of the place. On open end work, the shovel starts at the end of the slab and works across the face laying track as it goes.

The loading machine is serviced by a 6-ton gathering motor which usually pushes in 5 empties. As soon as the end car is loaded, it is shifted out on the entry or in a convenient cross-cut, the remainder of the trip pushed back and the operation repeated. When the five cars are loaded, they are hauled to a nearby side track and additional empties brought in. Steel cars with a capacity of 3½ tons are used.

When working at capacity, the double operation of preparing and loading coal requires a considerable force of men for the three machines, the greater number being employed on the day shift on preparation. The output per machine per

* Division engineer, The Consolidation Coal Company, Jenkins, Ky.

shift averages about 130 tons and in addition more than an equal amount of slate is loaded out.

Much the same method of mechanized loading is carried on at Mine No. 206. Here, however, different type loading machines are used and the operation is not quite so intensively mechanized as the middle parting averages but 6 in. in thickness and is hand loaded.

Two sections of the mines have been set aside for mechanical loading—two type 5-BU Joy Loading Machines being used on one and two type F. Coloder Machines on the other.

The preliminary work of preparing the places for loading is the same with each type of machine and the development of the territory is similar.

When operations first started, rooms 12 ft. wide were driven on 90 ft. centers. with crosscuts opposite each other and forming blocks 78 ft. square. On the completion of the rooms, pillar work was started in the Coloder section by attacking the blocks on the two gob sides at the same time, first butting off through the block and then slabbing back from the two places.

While fairly good results were obtained, it was found that the first butt offs were too long. Also the square corners of the pillar made it difficult to handle the machine, necessitating that a considerable amount of coal be cut from the points of the pillars, leaving a very wide area in which it was difficult to hold the roof. The blocks were therefore split and the pillars brought back open end. This was also done on the Joy section. On all new work laid out for the machines, the rooms are driven on 50 ft. centers with crosscuts slanted ahead.

Throughout the entire cycle of work, operations on the Joy section differ from that on the Coloder section, in but one respect. With the Joy machines, on open end work, as soon as the face is cut, cleaned and drilled, the track extending along the face is torn up, and the coal loaded from the end of the slab cut in the pillar—track being laid as the machine advances across the face—this track in turn being the track from which the next slab cut is made.

The track across the open end face on the Coloder section is not torn up when cutting and cleaning is completed, but is used by the machine until the entire slab cut is loaded out, when it is shifted to the face. With both types of machines, heavy timber is set along the track on the gob side, additional timber being set when necessary.

The complete cycle of work requires two shifts, the cutting, cleaning, timbering, drilling and track work being handled on the day shift and the shooting and loading of coal on the night shift.

All places are cut in the parting with a Jeffrey Arc Wall Machine with a 10-ft. cutter bar. Nearly all the parting is cut out but what remains is trimmed down by the slate men who follow the machines, thoroughly cleaning the kerf, face of coal and bottom. Great care is taken in this operation.

The drillers follow the slate men, drilling with electric drills, 3 holes being placed in the top bench and 3 holes in the bottom bench in narrow places, while on the open end faces the holes in both top and bottom benches are drilled from 5 to 6 ft. apart. In narrow work, an average of two sticks of Duobel are shot in lower holes and 1½ sticks in the upper holes. The charge is about the same for the open end places.

Raking long face with Goodman slabber

Slabber completes raking

Final cleaning of parting by hand

The refuse from the machine cuts is loaded into mine cars in narrow work and thrown into the gob on open end faces.

Coal is shot on the night shift. On open end work in the Joy section, it is shot in both benches as needed, while on the Jones section, both benches are shot before loading starts. In narrow work, both benches are shot before the loading machine enters the place.

Each loading machine is kept supplied with cars by a 6-ton gathering motor, the procedure being the same as described at No. 205 Mine.

Face of room, parting cleaned out, ready for coal to be shot—Mine No. 205.

Long face parting, cleaned, ready to shoot coal—Mine No. 206.

Showing the roof action in Mine No. 206.

During 1928, 195,000 tons of coal were loaded at this mine with the loading machines, the average tonnage per machine per shift being from 220 to 250. The tonnage per man per shift was between 8½ and 9.

There has been very little trouble from the roof either at No. 205 Mine where the maximum cover is about 250 ft., or at No. 206 Mine where the maximum cover is 350 ft. When open end work started at No. 206, it was in a section where the rooms had been driven for some time and the loss of the face was frequent. As the pillar line retreated to new work, conditions became better and at the present time little trouble is experienced. When a face is lost, it is generally at a cross-cut and in that case a new butt off is necessary.

The posts along the open end faces are of good, solid timber usually 8 in. in diameter. At the tight end of the pillar they are set 3 ft. apart, the distance increasing to 6 ft. at the open end. The rows are from 7 to 8 ft. apart.

The timbers do not break the top at the face, but there is a gradual subsidence of the roof, the break usually being 15 to 20 ft. back. Timbers are not recovered.

Most of the mines have been developed with a main entry system of 7 places: three center places for empty and loaded haulways and traveling way, and a pair of airways on each side. Later development provides for four places, of which two are for intake air and two for return air.

Face entries consisting of four places are driven approximately every 1,600 ft. on the mains, and butt entries turned from them so as to give room lengths of 250 to 300 ft.

Rooms are not turned until the butt entries reach their limit and then only as the retreating pillar line requires. All entries are driven 12 ft. wide on 35-ft. centers. The majority of rooms are driven on 50-ft. centers and all are 12 ft. in width.

Where top conditions permit, the pillars are brought back on the open end. As a rule, however, butt offs or pockets are driven through the pillar about 6 ft. from the end. The 6-ft. wing is then removed and another pocket started.

In some sections of the low coal area, a short room method is used. The butt entries are driven as usual, and on completion, pairs of rooms on 35-ft. centers are driven from one butt entry to the other, at intervals of 105 ft. The solid blocks between the rooms are then worked by short rooms on 35-ft. centers. Pillars are recovered by the butt off method. This system is advantageous where the roof is bad as places can be driven up and pulled back quickly.

The presence of the slate parting in the seam makes the preparation difficult, especially when the cleaning must be done at the face and a very high standard of quality maintained.

Cutting for the hand loading sections is done at night and in nearly all the places is in the parting, which is cut out where it does not exceed 6 in. If thicker, the remainder must be barred down by the loader in the course of cleaning his place. Cutting is not difficult and each machine cuts from 30 to 45 places per shift.

The loader, on his arrival in the morning, first loads out the machine cuttings and thoroughly cleans the cut—great care being taken to see that no loose dirt is left in the back and on the sides. The kerf, face of coal and bottom are then swept with a broom and as an additional precaution, shoveling or floor boards are placed on the bottom close to the face.

The coal in narrow places is shot with two holes in the top bench and two in the bottom bench. At some mines the top holes are drilled at night by company men, using hand electric drills. All other holes are drilled by the loader.

A mounted drilling machine is used at one mine with considerable success. The middle parting here is from 15 in. to 30 in. thick, and the cutting is done directly under it. Owing to its thickness it is necessary to drill and shoot the parting so it can be handled and the kerf cleaned.

Formerly, holes were drilled over the parting as it was too hard for the ordinary electric drill. This method of shooting badly shattered the top bench of coal and did not break up the parting sufficiently for convenient handling.

The use of the mounted drill has eliminated this condition. Two rib holes are quickly drilled simultaneously in the parting, followed by two holes in the top

bench of coal. The middle rock hole is drilled last and can be done by either one of the drills on the machine.

The machine is operated by two drillers working an 8-hour shift. At present it is used only in narrow work—28 places being drilled per shift. These places are 12 ft. wide and three holes are drilled in the parting and two in the top bench.

Holes in both benches of coal are placed from 10 to 15 in. from the rib, parallel to it and level. The top holes are first shot, one following the other and after the coal is loaded, the bottom holes are shot.

All shooting is done by a shotfireman, with cable and battery, who also loads and tamps the holes. Duobel, permissible powder, is used, a charge consisting of from 1 to 2⅛ sticks.

Great care is taken in placing the holes properly and in loading and tamping. The powder is placed in the back of the hole, after which a clay dummy is inserted and tamped lightly, leaving an air space of from 6 in. to 15 in. between the powder and dummy to cushion the shot, the remainder of the hole being tamped tightly. This method, it has been found, produces a maximum amount of lump coal.

Good track is one of the chief essentials in connection with mining operations, and to meet the demands of present day haulage, the main line system is rapidly being reconstructed. The original layout consisted of a double track system with an empty and loaded track in separate entries, laid with 40-lb. steel. This is now being replaced with a single track system with passing sidings where necessary.

Traffic on the main haulage is controlled by manually-operated block signals of the two position type. A motor can advance into a block only on a green signal. When it passes a green light, a switch is closed by hand which clears the block behind and closes the block just entered. Each side entry is provided with signal lights that protect the main haulage from trips coming out on the mains while a motor is in the block.

All new main line track is laid with 60-lb. rail, creosoted ties, manganese steel frogs, is well ballasted and has established grades and alignment. Specifications covering every detail of material and method of installation have been prepared, and are strictly followed, thus assuring that the installation as well as the material is first class.

Face headings are laid with 40-lb. steel and butt entries and rooms with 30-lb. steel, standard specifications for this track also being provided. Steel ties are used in rooms.

Main line track is bonded with 4/0 copper bonds and these as well as cross bonds are electrically welded to the rail. 4/0 trolley wire is used on all haulage roads.

Ten-ton motors are used on the main haul and 6 ton for gathering. Several types of mine cars are in service, but they are rapidly being replaced with a standard steel car of large capacity.

Closely connected with the haulage is a dispatching system which is used at all mines with good results. The dispatcher is stationed outside near the tipple and dispatches all motor trips. Early each day each section foreman reports to him by telephone the number of men working and the number of cars necessary to clean him up. With this information the dispatcher is able to route the cars to the best advantage and see that they are kept moving. As each gathering locomotive reports by phone the number of cars placed on the side tracks the dispatcher knows the situation in all sections of the mine and can send cars where most needed.

A dispatcher's sheet showing the side tracks for each section and the number of trips to and from him is kept up during the day by the dispatchers and this information is of great value to the mine officials, who at a glance can tell which sections need their attention.

The importance of good power is recognied and a number of automatic substations are located on the surface at economical points and power transmitted into the mine through bore holes or outcrop openings. Large feeder cable is installed at all mines and kept close to the advance working faces.

With the tender roof conditions in nearly all the (*Continued on page* 632)

Joy loading machine in Mine No. 206.

Single-motion Myers-Whaley shovel loading coal on long face Mine No. 205.

Single-motion Myers-Whaley shovel loading parting refuse in Mine No. 205.

Mining System

of BELL & ZOLLER Coal & Mining Company

By WM. P. YOUNG *

Mine producing 80 percent of its output with loading machines and pit car loaders—Operation of mechanical loading described—Gathering methods and track lay-out illustrated—Snubbing pans have increased machine output and have made better domestic sizes

THE Ziegler mines, of the Bell & Zoller Coal & Mining Company are located in the southern Illinois coal field near the town of Ziegler, in Franklin County.

The entire production is from the No. 6 vein, which averages 9½ ft. in thickness, of which 8 ft. are taken in the mining. The coal is overlain by a weak gray shale, which necessitates the leaving of 18 in. of top coal in place for roof support. The bottom is a rather soft fire clay. A dirt band, averaging 1¾ in. in thickness and from 15 to 30 in. above the bottom, is the only regular impurity in the No. 6 seam.

The system of mining is the room and pillar, with entries driven 12 ft. wide, air courses 18 ft. wide and rooms from 24 to 30 ft. wide, depending upon the roof conditions. No attempt has been made to change or modify the system of mining with the introduction of mechanical loading.

At the present time the No. 1 mine is producing 1,100 tons of hand loaded coal, 2,600 tons of coal loaded with pit car loaders, and 1,800 tons of coal loaded with Joy loaders. The tonnage from the pit car loaders and loading machines can be materially increased by the installation of additional units as market conditions justify. In this discussion mechanical loading only will be considered.

Before any start was made on a mechanization program, it was decided to train our own men to fill every position on the crews rather than to get experienced men who were not known to us. It was also decided to start but one crew at a time, and to bring each new crew up to a fairly efficient plane of operation before attempting to start another crew. In selecting the men for the crews only those whom we felt were particularly adapted for the work were chosen. It was possible to organize good crews without in the least interfering with our tonnage.

It was deemed advisable not to place the machines in room work which had been partially worked out by hand loading, but rather to start the machines on new territories. As sufficient new room territory was not available in the section of the mine where the machines were to be placed, the first four machines were started on development work in order to obtain the necessary development as quickly as possible. The last two crews were started in room work. At the end of four months sufficient entries had been driven so that three of the development machines were transferred to room work, leaving one crew to continue the development.

The general plan of operation on development work is to give each Joy loader not less than 12 entries if the coal is blasted with permissible explosives. However, with 12 or 14 entries it is necessary that the snubbing and shooting be done on the night shift, thus eliminating the possibility of double-shift operation. Cardox is used as a blasting medium in development work with as few as six entries to the loading machine, without seriously interfering with the efficiency of the crew, due to the limited number of working places. It has also been possible to work a double shift on development with the use of cardox, as each shift can complete all the necessary operations during their shift. Development work is done with both permissible explosive and with cardox, depending upon the number of entries available for the loading machine.

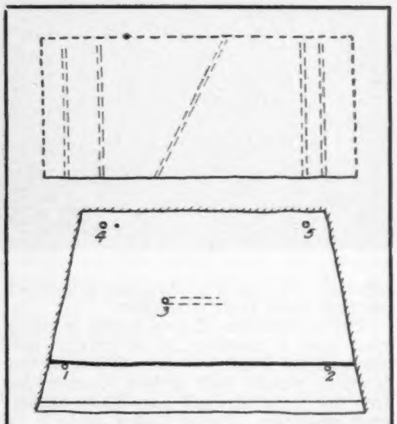
Each machine loading room coal is assigned 18 to 20 rooms, so that all operations can be performed on the day shift under the direct supervision of the foreman in charge of the crew.

A crew consists of 1 loading machine operator, 1 loading machine helper, 2 undercutting machine men, 2 drillers, 2 snubbers, 1 clean-up man, 2 motormen, 1 triprider, 1 trackman, 1 timberman, 1 motorman, and a triprider, whose time is divided between 2 machines, and 1 foreman, a total of 16 men including the foreman. The work of the crew is roughly divided into face preparation, loading and haulage.

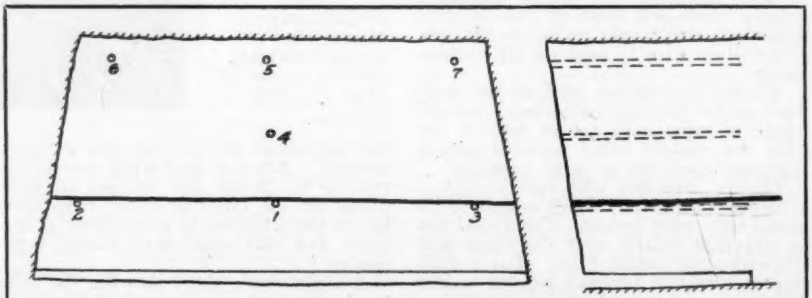
For both room and entry work the undercutting is done with shortwall cutting machines equipped with either 7½ or 8½-ft. cutter bars. On an average from 8 to 9 places must be undercut each shift in both room and entry work in order to keep the loading machine "in coal."

The bringing down of the coal face in such condition as to make the loading as fast as possible and at the same time produce the largest percentage of domestic sizes possible is one of the most important operations in the loading cycle.

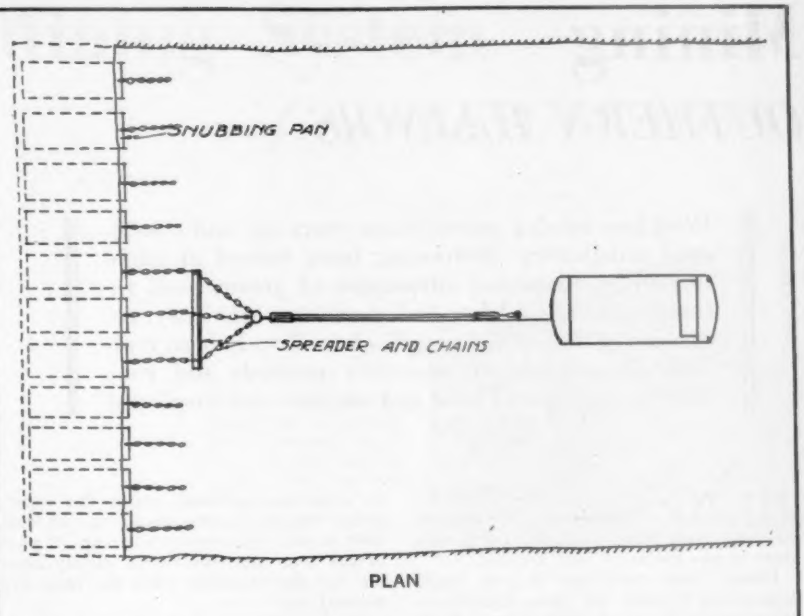
*Assistant general superintendent, Bell & Zoller Coal & Mining Company.



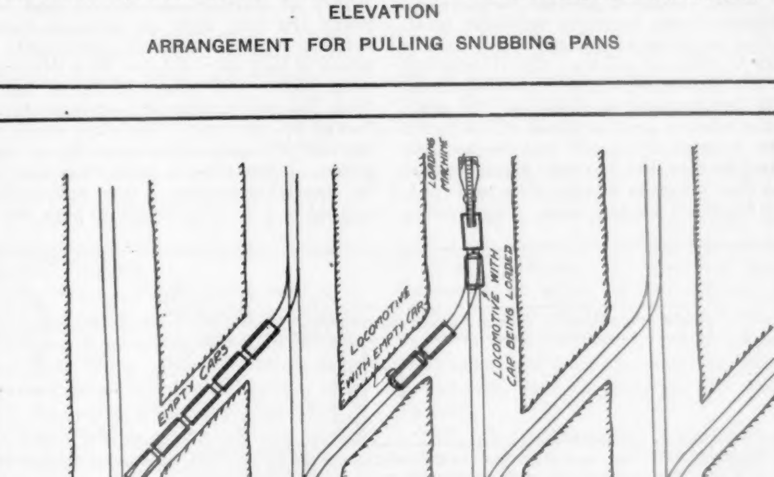
LOCATION OF DRILL HOLES IN ENTRIES



LOCATION OF DRILL HOLES IN ROOMS



ARRANGEMENT FOR PULLING SNUBBING PANS



HAULAGE LAYOUT FOR ROOM WORK

The location of the shot holes, the method of loading the holes, the type of explosive used, and the amount of snubbing done are the governing factors in arriving at the desired results. No fixed rules can be applied to these operations, as the operator of each mine must determine by experiment and experience how to shoot his coal to obtain the best results for machine loading. The average miner drills, snubs and shoots his place in a manner that will enable him to place his coal in the car with the least possible effort on his part, but it does not follow that the same procedure should be followed in preparing the coal for machine loading. In fact, by preparing the coal for loading in the same manner as it is prepared by the miner, the loading machine must also do the digging that is done by the miner, as all time spent in digging by a loading machine is lost time, although a time study may not show it as such.

An electric rotary drill is used to drill all holes for permissible explosives and the same type, but more powerful, drill is used to drill the 4-in. holes for cardox shooting. A seven hole-round is used in rooms and a five-hole round in entries with both permissibles and cardox. Tests have proven that, with cushion blasting and using the minimum amount of explosives in each hole to accomplish the desired results, these hole-rounds bring the coal down in better condition and square up the faces better than it is possible to do with fewer holes. Two post set-ups are required in entries and three in rooms, and the average number of 6½-ft. holes drilled by a crew per shift is 45 in entries and 57 in rooms. The two-man drilling crew removes the machine cuttings from under the cut and place the snubbing pans under the cut in addition to drilling, loading and tamping the holes.

By mechanically snubbing both rooms and entries, the loading speed of the machines has been materially increased, and a larger percentage of domestic sizes has been obtained than was formerly obtained with hand loading and close supervision. Snubbing is done by shooting down the 15 to 30 in. of coal between the kerf and dirt band on to snubbing pans and then pulling this coal from under the face on the snubbing pans.

Before the snubbing pans are placed under the face the machine cuttings must be thoroughly cleaned from the cut, so that the pans rest on the solid bottom. The pans are 2 ft. wide and are placed on about 3-ft. centers across the face. After the snubbing shots have been fired, 3 to 4 pans are hooked to a spreader and pulled with blocks and cable from under the face by a locomotive. As a rule, the dirt band comes down in large slabs on top of the snubbing coal, and when the pans and coal have been pulled from under the face the dirt band is separated from the coal and thrown into the gob. Any of the dirt band that remains in place is wedged down by the snubbers and thrown into the gob. After a working face has been snubbed from 15 to 30 in. high, from rib to rib, and the full depth of the cut, it is then only a question of the proper placing and shooting of the top holes to prepare a pile of loose lumpy coal for the loading machine.

In a well-balanced loading unit the loading itself should be the easiest operation to perform, for it is only by making it possible (*Continued on page* 627)

Long Face Mining

in SOUTHERN ILLINOIS

Long face mining started three years ago and considered satisfactory—Retreating faces turned at angle to entries—Expected advantages of greater coal recovery, increased labor and machinery efficiency, reduction of timber and supplies have largely been realized—Description of operating methods and roof action—Equipment used and number men employed

By ROY ADAMS *

ABOUT three years ago long face mining was started in Old Ben Coal Corporation's mine No. 8. A section of the mine had been worked to the boundary and only the barrier pillars, 110 ft. thick, on each side of the cross entries remained. All panels adjacent to the pillars were squeezed, and in most cases surface subsidence had occurred. The pillars, therefore, carried only the weight of the direct overburden of 450 ft., consisting of grey shale to within 30 ft. of the surface, with the exception of two 4-ft. strata of limestone, one about 100 ft. above the coal and the other 25 ft. higher.

The long faces were started by first driving a room into the pillar at an angle of 60 degrees from the entry, the outby rib of which became the working face, having a length of about 120 ft. The working faces of the two pillars were kept opposite for obvious reasons, two faces being the territory for one unit of operation. Equipment and men for the unit consisted of:

One caterpillar-mounted loading machine.

One 8-ton gathering locomotive .

One shortwall undercutting machine.

One post-mounted portable electric drill.

Crew of 11 men, consisting of 1 motorman, 1 trip rider, 1 loading-machine operator, 1 loading-machine helper, 2 cutting-machine men, 2 drillers, 1 timberman, 1 track man, and a face boss.

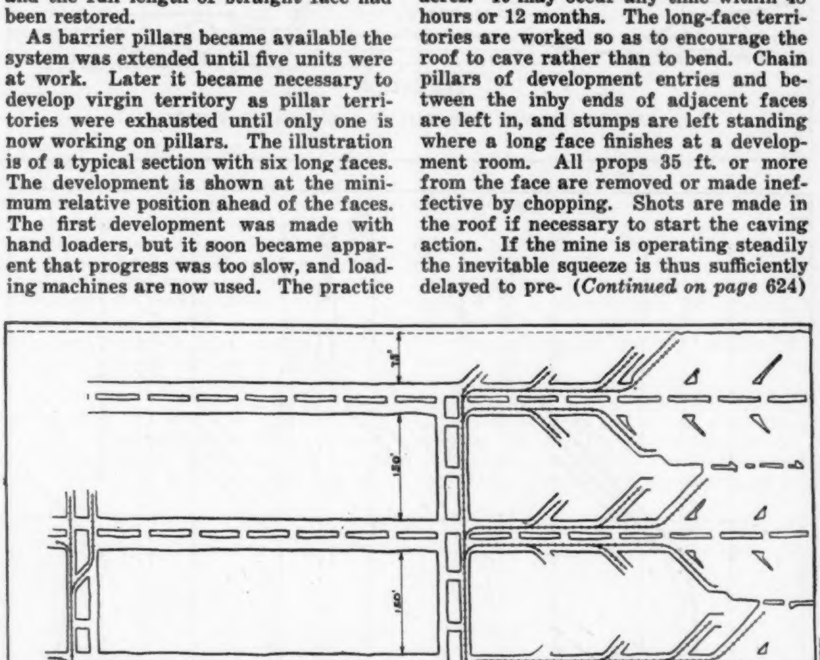
All work was done on the day shift except firing the shots, which was done by the regular shot firers after the day shift was out of the mine. One face was cut, drilled, and shot, and the track shifted, while the loading machine worked on the other. Each face furnished approximately one day's loading.

So long as the mine worked steadily the roof gave no trouble, but when the operating time dropped to three or four days a week the faces could not always be kept open, occasionally were lost altogether, and had to be reopened by dropping back in the solid and driving another room. To overcome this handicap it became the practice to keep two or three rooms working at points about 100 ft. apart, using hand loaders, the one nearest the long face being available for a new start in the event of roof trouble.

Under these conditions it was found impractical to keep the faces straight or to maintain the angle of 60 degrees from the entry. Frequently in making a new start the room would not have been driven far enough. In order to supply a full day's run for the loading machine it was necessary to slab along the rib and across the face, and so continue with succeeding cuts until only a small pillar remained next to the worked-out panels and the full length of straight face had been restored.

As barrier pillars became available the system was extended until five units were at work. Later it became necessary to develop virgin territory as pillar territories were exhausted until only one is now working on pillars. The illustration is of a typical section with six long faces. The development is shown at the minimum relative position ahead of the faces. The first development was made with hand loaders, but it soon became apparent that progress was too slow, and loading machines are now used. The practice of driving occasional rooms for emergency use has become standard. If local falls occur, temporarily shutting off part of the long face, the rooms supply loading for the machine until the falls are cleaned up.

To say that roof control is actually accomplished would not be strictly in accordance with the facts. Symptoms of an impending squeeze in this mine are well known and, although the time when a squeeze will occur may not be forecast with certainty, a squeeze is inevitable when 50 percent or more of the coal has been removed from an area of 4 or 5 acres. It may occur any time within 48 hours or 12 months. The long-face territories are worked so as to encourage the roof to cave rather than to bend. Chain pillars of development entries and between the inby ends of adjacent faces are left in, and stumps are left standing where a long face finishes at a development room. All props 35 ft. or more from the face are removed or made ineffective by chopping. Shots are made in the roof if necessary to start the caving action. If the mine is operating steadily the inevitable squeeze is thus sufficiently delayed to pre- (*Continued on page* 624)



* Chief engineer, Old Ben Coal Corporation, Christopher, Ill.

Mining System

of SHERIDAN-WYOMING Coal Company

Acme Mine of the Sheridan-Wyoming Coal Company, showing one the modern tipples and rescreening plant

Mining a 22-ft. seam without timber—Coal in transit at quitting time dumped to provide starting cars for next shift—Haulage system revised for mechanical loading—Additional power required—Higher recovery, low investment and operating costs and increased safety obtained.

By Edward Bottomley *

THE Sheridan-Wyoming Coal Company is operating 3 mines on a 100 percent mechanical basis. The first mechanical loaders were installed by this company in the Acme mine during the months of June and July, 1925. The following year the Monarch mine was partially equipped, and the year 1928 found all 3 mines equipped with loaders and all contract work entirely eliminated. A total of 19 loading machines are in use at the 3 mines, with an average daily production of 5,200 tons.

The coal seam now being worked is what is known as the Monarch seam, which has a thickness of 22 ft., the bottom 18 ft. being absolutely clean, making ideal conditions for mechanical loading. The seam has a maximum pitch of 2 degrees to the northwest. No timber is used, the coal being mined from 10 to 12 ft. high on the advance and the remainder is left for roof.

All entry and other narrow work is driven with the model 5 BU Joy loaders. A sufficient number of these machines is carried at each mine to keep development work well in advance of the Goodman power shovels, which are used for loading room coal and pillars. Joy machines are used to some extent in room or wide work; when there is not sufficient entry work to give them a full day's work, there is always available loading provided in the nearest room. During the busy season at least one machine at each mine is double shifted. Joy machines are generally used for this purpose, driving entries.

In our district all coal in transit at quitting time is dumped after the whistle blows. This provides sufficient empty cars for the night-shift machines and insures a good start for the tipple the next morning. Without this dumping arrangement at night, double-shifting a machine would hardly be feasible with us, as it would not pay to load all of our empty cars at night and then have the loaders wait for empties the next morning.

With few exceptions, all of the drilling and cutting is done on the day-shift. This runs up the maximum demand for power somewhat, but we believe that this work can be supervised and regulated much better during the day time than would be the case if the work was all done at night. In our field, drilling holes and charging the shots required very close supervision for mechanical loading and, no doubt, this same is true in many other districts. Eight shots are used to shoot down the room faces and 6 for the entry faces. The average consumption of powder per ton of coal is 2.35 pounds. Seventy-five to 100 tons of coal are obtained from a room cut and 40 to 50 tons from entry cuts.

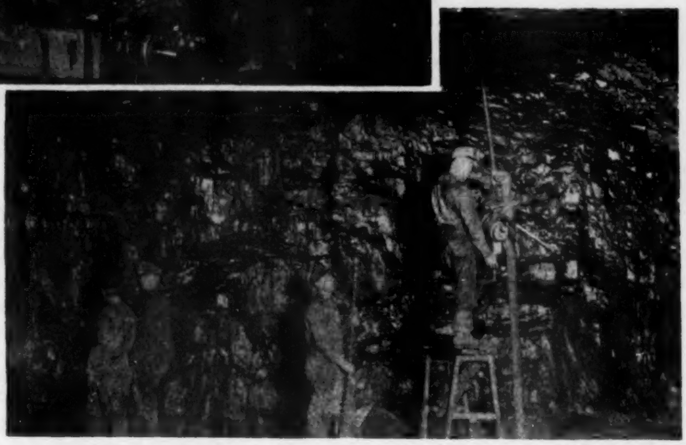
No radical changes were made in our system of mining when machines were installed. The panel system of room and pillar mining, which was in vogue when mining was done by hand, is still carried on with a few changes. Eighteen room panels are driven, the Joys driving up a panel to its required length, driving the rooms to 100-ft. depth and 28-ft. width with one haulage slant and cross-cut between each room. The panels are then ready for the Goodman machine, which works on the inside 5 rooms, advancing these to their proper depth and then pulling back the pillars. They are then ready to move to the next 5 rooms. Room centers have been increased from 50 to 60 ft., and room lengths have been extended from 250 to 350 ft. In some few instances rooms have been carried 500 ft. Rooms have also been widened from 22 to 28 ft.

The haulage system had to be revised considerably. It was also found necessary to change the track arrangement somewhat, in rooms especially. Double tracks are laid in each room, the Goodman loader working between tracks. With this system there is always an empty car on one track ready for loading as soon as the car on the other track is topped off. At two of our mines, where the main haulage is about 2 miles long,

* General superintendent, Sheridan-Wyoming Coal Company, Sheridan, Wyo.

Left — Coal on the way to the tipple

Center—Joy machine loading coal



Right — Preparing the face for shooting, which is done at night. Note the thickness of the seam

partings were lengthened and a passing track installed. Twenty-pound rail is used in the rooms, 30 and 45-pound rail in the cross entries, and 60-pound rail on the main haulage road, 10 and 15-ton locomotives being used on the main haulage road. Larger cars, and more of them, were found necessary to obtain the best results from this new system of mining. In the Monarch and Acme mines an average of 50 mine cars per machine is necessary to maintain an even production per machine. This number per machine is due in part to the long distance that coal must be hauled to the tipple.

Getting down to the actual system of handling the work, we have varied but little from the system inaugurated at the inception of mechanical loading. Ordinarily a crew for a machine consists of from seven to eight men. One cutting machine is provided for each loader. First the coal is cut and the two men that operate the cutting machine usually drill the holes and remove all machine cuttings from the kerf (no snubbing is done in this field). Three to four rooms and five to six entries are required for a full day's loading for one machine.

Usually the holes in dry places are charged and tamped by the cutting and drilling crew. Pellet powder and clay dummies for tamping are used. Powder and tamping in this form is not only safer, we believe, but greatly expedites this work. Although there is no effective shot-firing law in our state, as a safeguard to the life and health of the underground employes no shooting is permitted during working hours and all shots are fired by a shot firer after the day shift has left the mine and before the night shift enters.

Next comes the face man, whose duty it is to put the place in readiness for the loading crew. All loose coal that has been left standing by the shots is thoroughly trimmed down from the roof and face. The same man extends the track when necessary. Steel ties are used for all room track, which greatly expedites and simplifies the work, besides bringing the rail much closer to the floor than if wood ties are used, which is well worth considering with every type of loading machine; and when it is necessary to move the loading machine of the caterpillar type over this kind of track it can be accomplished much more readily and with less damage to the ties. Then, again, the face man does not have to carry a set of tracklayer's tools to lay a length of track. An experienced tracklayer, however, is carried in each section to lay all necessary switches and curves.

After the face man has put the room or entry in shape, next comes the loading machine. The loader crew in our district that performs the actual loading consists of an operator and an assistant and two men that serve the loader. The system of serving the Joy and Goodman loaders is carried on in our mines practically the same as elsewhere, with perhaps a few variations. Two horses are used in each room to pull cars to and from the Goodman loaders. Five-ton Reel locomotives are used to serve the Joy machines. One can not, or should not, in my opinion, lay down a hard and fast rule for serving the loader, not even in the same district. Conditions vary so that even in the same mine slight variations are necessary, and the management at each mine should determine what is best. Cooperation and team work on the part of the management and the loading machine crew is highly essential for any company to make a success of this system of mining.

Additional power was required when mechanical loading was installed. Before the installation at the Acme mine, D. C. power was furnished by one 150-kw. generator set outside and one 150-kw. generator set inside the mine. Since that time there has been added one 100, one 150, and two 200-kw. generator sets.

I will say in conclusion that we have found after nearly four years of this system of mining coal, that it has not only been profitable but a very satisfactory method of producing coal. A given tonnage may be produced from far less area than hand mining, thus cutting down the investment in track, timber and the general maintenance cost thereon. Pillar-work, on account of quick recovery, is much safer and will produce a better grade of lump coal. Skilled men are employed for nearly every branch of the work. This class of labor formerly shunned the coal mines, but are now attracted to this kind of work, or at least that has been our experience. As a result, the labor turnover with us is practically nil; and last, but not least by any means, major accidents have been materially reduced, dropping from a cost of 2 cents a ton when on hand labor to an average of \$0.0045 per ton the last four years of mechanical loading, and no fatal accidents have occurred in our mines since the last year of hand work, producing during that time 4,000,000 tons of coal.

Long Face Mining

with the SHAKER CONVEYOR and the UNIVERSAL DUCKBILL

By J. E. EDGEWORTH*

Long face mining with conveyor and duckbill—Seam varies from 5 to 9 feet in thickness and pitches 12%—Details and sequence of operations described including methods of timbering—High percentage of coal recovered but small pillars are left as roof support—Successful roof action.

THE mining of coal on the long face by means of the shaker conveyor equipped with the Universal Duckbill has been in use during the past year by the Union Pacific Coal Company in their No. 8 mine, located at Rock Springs, Wyo. This method of mining and use of equipment has been so successful that a paper covering this should be of some interest to the mining profession.

The seam worked is known as No. 1, and it varies in thickness from 4 ft. 7 in. to 9 ft. of a subbituminous coal. It pitches 12 percent and has a fairly good sandstone roof and a hard slate bottom. However, there is ever present a cap rock varying from 2 in. to a foot, and in some cases to 4 ft. in thickness, which is very friable. A characteristic of this seam is the presence of a yellow band varying from 1 to 3 in. thick, located about 18 in. from the roof. Occasionally a band of bone from 2 in. to a foot thick is to be found directly under the yellow band.

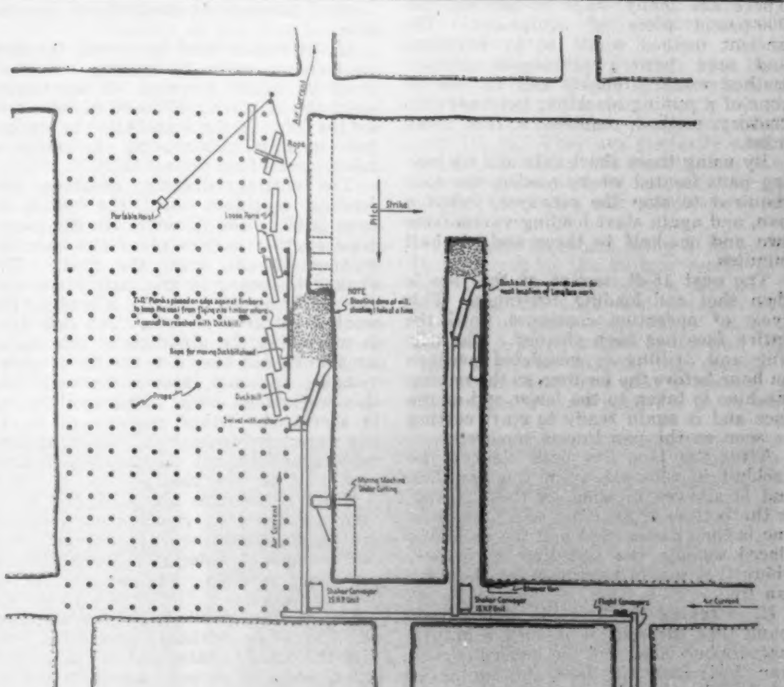
The method of working this seam may be seen in accompanying sketches. The coal in this case was developed for scraper loading, which required a four-entry system. However, where the shaker conveyor and the duckbill are used for mass production a three-entry system is used. These are the aircourse, the haulage entry, and the breaking entry. These entries are driven on the strike and are about 450 ft. from the next set of entries. Three 50-ft. pillars are left to protect the haulage and air course. This leaves 300 ft. for the face, making the line of the face directly on the line of pitch which is necessary in order to take advantage of the slips in the roof.

A plane 10 ft. wide is driven from the breaking entry to the air course of the next set of entries. By driving this plane to the air course, ventilation is assured. This distance is 350 ft. However, the section of this plane used as the face is only the lower 300 ft., thus leaving 50 ft. as a pillar to protect the air course.

* The Union Pacific Coal Company, Rock Springs, Wyoming.

A drag conveyor is placed in the breaking entry along the low rib, which in turn discharges onto another short drag conveyor located in a crosscut which extends to the haulage entry. The drive engine for the shaker conveyor is set and braced with four or six adjustable metal jack pipes. While this is being done the mining machine cuts the lower end of the face. A row of timber is placed within 2 ft. of the cut face on 4-ft. centers. Between this line of timber and the face are placed four boards 2 in. x 12 in. x. 16 in., thus forming a bin.

The drive pan, which is attached to the engine, is also the discharge pan, and is just long enough to reach the drag conveyor, located on the lower rib. To this pan is attached the Universal ratchet and the duckbill. The lower 15 ft. of the face is then shot, and the loading starts. The duckbill is advanced into the



PLAN OF ARRANGEMENT OF CONVEYOR ON LONG FACE WORK

bin of coal provided by the boards and the back of the cut.

After the duckbill has loaded all the coal directly in front of its path it is brought back to the ratchet and revolved 3 or 4 ft. laterally, and again allowed to extend its full length. This procedure is followed four or five times until all of the shot coal has been loaded. While this is going on the mining machine continues to cut ahead of the loading. The machine crew also does the drilling. The timber crew is adding props and moving the boards to the next section to be shot.

The duckbill is then detached from the drive pan and another pan is inserted. There are a few important details which play a large part in reducing to a minimum the addition of a pan. We found that using two bolts and two nuts to hold two pans together was an eighteenth century method. Threads on these bolts were continually becoming battered; wrenches were needed to fasten them. The Machatson pan fastener was developed to take their place. It required only a hammer, and everyone will agree that this tool requires less skill in handling, is less apt to be lost, and is less expensive than is a wrench.

There are three parts to this Machatson fastener; the shank, the strap, and the wedge. Three blows of a hammer will install them. First the shank is driven through the adjoining lugs of the pan; second, the strap is tapped into place; and third, the wedge is driven through the slot in the short bend of the shank. To remove a fastener this order is simply reversed.

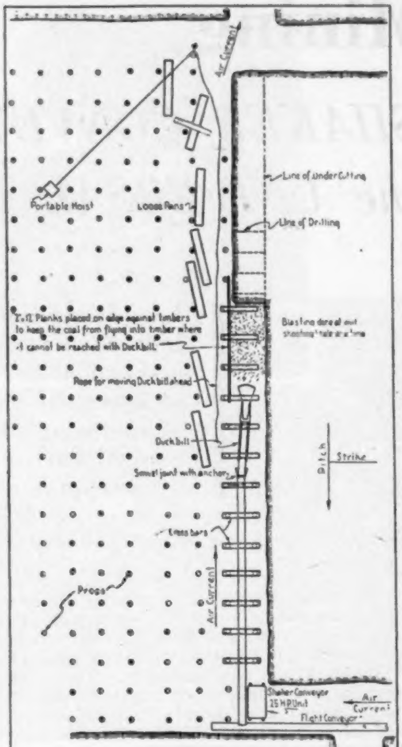
To insert a pan, the duckbill mechanism must be loosened from the pan line and moved far enough ahead to allow another pan (13 ft.) to be put in place. There are many ways of moving this 900-pound piece of equipment. The ancient method would be by crowbars and man power; nineteenth century method would probably call for use of rope of a mining machine; but twentieth century method requires a fast small hoist.

By using these short cuts and by having pans located where needed, the time required to stop the conveyor, insert a pan, and again start loading varies from two and one-half to three and one-half minutes.

The next 15-ft. section of the face is then shot and loading continues. This cycle of operation continues until the entire face has been cleaned. The cutting and drilling is completed perhaps an hour before the loading, so the mining machine is taken to the lower end of the face and is again ready to start cutting as soon as the pan line is removed.

After the face has been cleaned the duckbill is removed from the pan line and is allowed to slide on the pan line to the bottom or starting end. The pan line is then dismantled and the pans are placed outside the last line of timber, where they are in readiness for the next pan line.

If, in taking the first cut, it has been found that the roof is of such a nature that timber need not be placed closer than 7 ft. from the face, the engine is not moved and loading can start immediately. However, if the roof is tender and the cap rock is loose the engine will have to be moved one cut distance and follow the same method as before. The better roof only requires moving the engine every other cut, and the difference between the pan line and the cut of coal



Plan of
Working Long Face with Shaker Conveyor
Under Tender Roof Conditions

is taken care of by means of the swivel located between the duckbill and the pan line.

If the engine need be moved, the time required to again be loading will vary from 90 to 120 minutes. If the engine need not be moved, 30 to 40 minutes will do the job. If the installation is worked but one shift, this moving can easily be taken care of on the off-shift.

The cutting, drilling, shooting, and loading continues until the mined-out area is 90 to 100 ft. wide. In the meantime another narrow plane has been developed 105 ft. from the first. The shaker is moved to this new plane and the timbers are pulled, allowing the worked-out area to cave. The new face is worked in the direction of this caved area until not over 8 to 10 ft. of pillar remain. In many cases we have cut into this worked-out area. This small pillar is sacrificed. Other methods of working were tried in hopes of having to sacrifice no pillar, but to date this method seems by far the best.

Many advantages are to be had from this method of mechanical loading. Where impurities are encountered they can be removed underground, as the three conveyors provide 300 to 500 ft. of picking tables.

The cutting, drilling, and loading can all take place without interfering one with the other; consequently, the installation could be worked two shifts where shooting must be done on the off-shift, and three shifts where shooting can be done at any time.

Three hundred sixty tons have been loaded in this way in eight hours. However, an average of 250 tons can be maintained in our case. By the use of 8-ft. bars and adjustable metal screw jacks for temporary timber it is possible to maintain timber within 2 ft. of the face at all times. The coal to be shot is at all times open on three sides, so a high percentage of lump coal can be obtained.

It is the opinion of those in charge of this work that it contains unlimited possibilities.

LONG FACE MINING IN SOUTHERN ILLINOIS

(From page 620)

vent closing of the faces.

A great deal may be said both for and against this system. Results obtained over a three-year period have justified the experiment, and the general plan will be continued. It was started primarily in an effort to reduce lost time of loading machines due to car changes, but other benefits were anticipated, e. g., greater coal recovery per acre; larger percentage of lump; increased efficiency of cutting machines; reduction of timber costs; less track material and labor for a given tonnage; concentration of production area and better supervision. Most of these have been realized. Loading-machine delays for car changes were reduced in the ratio of five to one. During periods of steady operation the recovery per acre is 10,000 tons, an increase of 30 to 35 percent over the prevailing room and pillar panel system. The percentage of lump coal has not been increased, mainly because the entire face is shot down before any loading is done and enough explosive must be used to insure proper breaking of the coal for loading. The result is that some shots are too heavily charged. Increased efficiency of cutting machines is obvious. An appreciable reduction in timber cost is obtained because of the quick recovery and reuse of props. The useful life of a prop in one setting seldom exceeds two weeks. If it is sound it is then recovered and reset at the face. About one-third as much track is required for the same tonnage as would be needed in rooms.

SAMPLING DUST IN ROCK-DUSTED MINES

The rock-dusting of bituminous mines is recommended by the Bureau of Mines, not only because it renders the coal-dust inert to explosibility, but also because the non-combustible condition does not change rapidly in character, as is the case with water. To obtain the full benefit of this explosion-prevention method, however, the dust must be sampled periodically, preferably monthly, to give a check on the average condition of the dust.

The periodical samples should be collected from at least one representative point in zones not over 1,000 ft. long, on all entries, and in rooms. The road-dust should be sampled separately from the rib and roof dust or timber dust.

The scoop and brush method used by the Bureau of Mines for collecting samples is recommended, but any method that will obtain representative samples may be employed. All samples should be properly identified, so that after determinations are made, the results can be entered as a permanent record.

Further details regarding the sampling of dust in rock-dusted mines are given in Bureau of Mines Information Circular 6129, by C. W. Owings, associate mining engineer.

Longwall Mining

at PARIS, ARKANSAS

By V. C. ROBBINS *

Conveyors introduced to eliminate face track in longwall—Reduced cost and increased output with improved lump result—Flat steel "scow" then developed—Large lumps broken to market size by air hammer

THE increasing popularity of Paris coal in the Southwestern markets during the last few years aptly illustrates Elbert Hubbard's famous remark about the mouse trap. The adoption of modern mining methods has made possible the production of a superior grade of domestic coal, and a market for the field output has been developed largely at the expense of less satisfactory coals of similar grade.

Although located only a few miles from the Arkansas semi-anthracite and bituminous mines that have been working on the Hartshorne vein for 50 years or more, coal from the Paris seam has hardly been recognized in the market for more than 15 years. For a much longer time the field had been known, and numerous attempts, all short lived and unprofitable, had been made to operate mines in the Paris vein on the same solid shooting-room and pillar plan as practiced in the thick vein mines of Sebastian County. When the idea of longwall faces undercut with machines was evolved, Paris coal soon occupied a unique position in the domestic market.

The field itself is small, covering only about 14 square miles, and is isolated both geographically and geologically from other Arkansas coal areas. The coal lies in a synclinal basin about 7 miles long by 2½ miles wide, outcropping at the edges, and pitching toward the center at the rate of 3 to 7 percent. The maximum cover at the center is probably not over 700 ft. The vein varies in thickness from 18 in. to 26 in., with many of the operating mines working coal less than 24 in. high. Of approximately 25,000,000 tons, comprising the total coal deposit, probably not more than 10 percent have been removed. Shipments for the 1928-29 season just closed indicate a production of slightly over 200,000 tons.

A typical analysis of the coal is as follows:

Moisture	2.22%
Volatile matter	17.57%
Fixed carbon	75.45%
Ash	4.76%
	100.00%
Sulphur	1.53%
B. t. u.	14,492

This would be considered a Loervolite, or coal 77, in Dr. Ashley's classification, although it is known locally and is sold in the market as "semi-anthracite."

As prepared for the domestic market the coal is hard and lustrous, disintegrating or discoloring very little in transit or storage, makes no clinker and gives off an intense heat without the smoke, gas or dirt that usually attends the burning of coal in the household stoves.

The introduction of the first longwall branch road work in 1915 was an attempt to reduce the cost, improve the grade and increase the output of Paris coal. In a small way the market had already been tried out, and coal dealers knew that well-prepared Paris lump would sell. At first the performance of the mining machines cutting in the hard rock under the coal was very discouraging, and the cost of brushing roadways every 40 ft. at union scale rates was prohibitive. As usual, the change to a new system of mining brought on its own peculiar problem. Costs were probably not reduced, but nevertheless some progress was made. Consumers were pleased with the longwall mined coal and dealers were hopeful that enough prosperous customers could be found to absorb an increasing output at prevailing prices. In the mines the branch road work proved that the Paris Field had a "longwall top," a vital factor in longwall work.

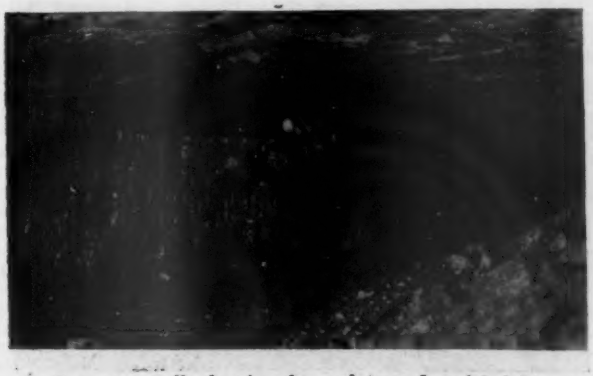
The heavy cost of brushing the branch roads soon led some operators to adopt face track. This had the advantage of reducing the cost of coal, because a brushed roadway was required only at 500-ft. intervals, and within a few years nearly all mines in the field were using it. However, it involved some extra cost for pushing coal to roadways and the small pit cars required by the restricted height made haulage, caging and hoisting expensive.

The disadvantages of face track work led progressive operators to seek further improvement. Mr. H. Denman, president of Paris Purity Coal Company, designed and built a chain conveyor incorporating several exclusive features, making it particularly applicable to low vein mines. This machine has since been adopted by all mines in the field where conveyors are used.

It employs either a single wide chain or two narrow chains as the transporting medium. The total height of the body of the conveyor along the wall is only 7½ in. They are generally used in lengths of 300 to 400 ft. with the haulageway at one end, or two conveyors on 600-ft. face with the roadway at the center.

Longwall machines using 4 ft. or 4½ ft. bars cut in the bottom rock. In a vein 18 in. to 20 in. high, a face 340 ft. long undercut 4 ft. will provide about 80 tons of lump coal. Each loader is assigned a 30-ft. section of the wall. The fallen coal is wedged into chunks of proper size and lump only is loaded. In most mines a draw slate 1½ in. or more

* Chief Engineer, McAlester Fuel Company, McAlester, Okla.



Conveyor wall, showing draw slate and coal height

Sprags under coal

Scow load at roadhead ready for transfer

Loading lump at roadhead

in thickness comes down with the coal. Frequently it is frozen to the top of the coal, but usually shells off easily. It is not altogether an unmixed evil, for it provides a few inches more of much needed headroom. This facilitates transportation on the conveyor and allows more freedom for the loader, increasing the output of both. The total loss of coal at the face is variously estimated from 3 to 10 percent, practically all due to small coal and slack being mixed up with draw slate and machine cuttings that must be thrown into the job. About 18-man shifts are usually required to complete the cycle on a chain conveyor wall. The loading rate for the crew actively engaged on the wall itself would be a little over 4 tons per man.

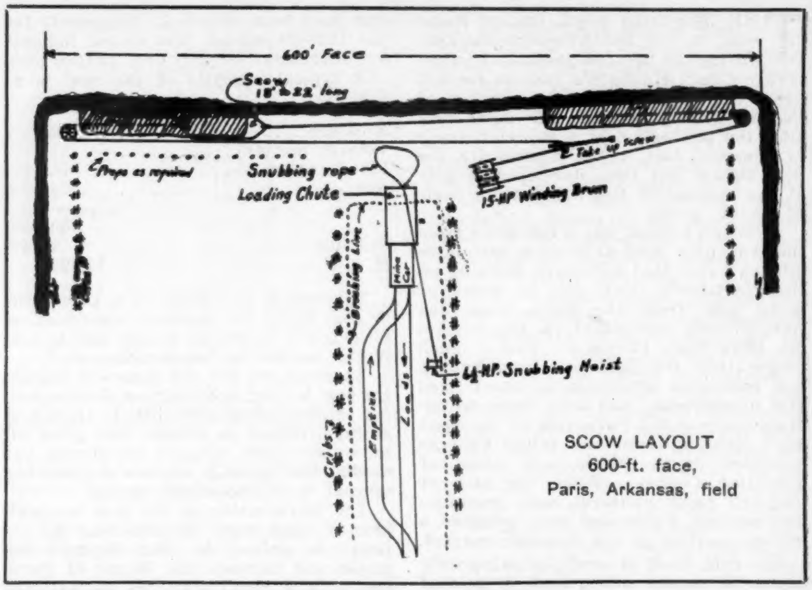
The application of the loading conveyor is designed by Mr. Denman to the operation of longwall panel faces has been very successful. It has reduced the cost per ton, increased the output per man, and provided an excellent grade of Paris lump coal in satisfactory quantity. With only one exception, every mine of any importance in the field is provided with face conveyor equipment, and approximately 60 percent of the total output is loaded by this means.

The use of conveyors requires the handling of 3 to 5 ft. of brushing on the roadways, generally taken in the bottom. The customary evolution from small to large cars, and narrow to wide gauge track is gradually taking place.

The roof is supported along roadways by packwalls or cribs, and along the panel faces by props. Breaks generally take place with about every 10 ft. of face advance, and as a rule are well under control of the operating crew.

Notwithstanding the success of conveyors as a means of moving coal from the face to the mine cars, some disadvantages have been experienced in certain mines. The distance from the first line of permanent props to the face of the 4-ft. undercut is about 9 ft., and it is frequently necessary to set temporary props in this space. Either these props have to be taken out and reset after the conveyor is moved up or the conveyor must be taken apart and moved around the props. An occasional bad roof break, squeeze or rock fall may require complete removal of the conveyor. Some trouble has been caused by draw slate and machine cuttings being spilled on the conveyor by the loaders.

Such difficulties, coupled with the fact that the conveyor itself is a rather expensive piece of equipment, led to the successful development at the Jewell Mine of the "scow" as a means of hauling the coal away from the face. The same plan of panel faces and roadway brushing is used as with the conveyors, but the conveyor itself is replaced with a machine quite similar to the old tail rope haulage equipment, except the trip of cars running on a track is replaced by



SCOW LAYOUT
600-ft. face,
Paris, Arkansas, field

Breaking lumps at shaft bottom

Coal at shaft bottom

a flat steel sheet pulled on the bottom underneath the fallen coal.

In one form of installation a large double drum hoist operates two scows or steel sheets 18 ft. long by 4 ft. wide. Both scows can be pulled separately or simultaneously as required. To make room for the hoist an entry 8 ft. high and 12 ft. wide is driven ahead of the panel face midway of the 600-ft. length. This is done on night shift. Each half of the panel face is cut by a longwall machine. The machine helper pushes the scow rope under the cut and places sprags 10 ft. apart under the coal. When the cutting is finished, the machines are parked out of the way. On the day shift two men on each end of the panel shoot out enough coal to make room for the sheaves and jacks to hold them in place. They next knock all the sprags, allowing the coal to fall down on the rope, and the draw slate is cleaned off the top of the coal. In the meantime loaders load coal on and near roadhead, the scow is then pulled under the nearest coal, the hoist reversed pulls it to the roadway, sometimes in one solid chunk 18 ft. long, but often it will break along the vertical cleavage planes into several chunks. When the coal reaches the roadhead, it is pulled on the pit cars by a small winch or snubbing hoist, usually one or two chunks on a car 7 ft. long.

For the latest improved form of the scow arrangement, 4 ft. of bottom brushing is taken up 11 ft. wide within about 10 ft. of the panel face. A steel transfer plate or chute extends from the top of the bench to the level of the mine car. The scow in this case is 22 ft. long. Its load of coal is turned through an angle of 90 degrees by a combined movement of scow and snubbing hoist, and loaded on the mine cars. After the coal is placed in position for loading, the scow is free to return to either side of the face, usually alternating between right and left sides. The 15-hp. electric scow hoist is located near the face at one side of the roadhead, and is moved forward with each cut. The endless hoist rope is provided with take-up jacks to maintain the proper tension.

On scow work the coal is undercut to a depth of 3 ft. as compared to 4 ft. on conveyor faces. This is on account of the fact that the miner can not reach back on top of the coal and clean the draw slate off a cut more than 3 ft. deep. For this reason the cost of cutting coal per ton is higher where scows are used.

As the chunks of coal pulled out on the scow are too large to be marketable, they are broken with air-operated hammers on the shaft bottom or on the slope tipples. With machines undercutting 3 ft. a scow face 340 ft. long will provide about 55 tons of lump in a 20-in. vein.

Approximately 12 man shifts are required for cutting, timbering, brushing and loading. The loading rate for this crew would be 4.6 tons per man. With the addition of a second machine and crew, however, the length of face operated and tonnage produced during the cycle can be doubled—hence the long faces and central roadways. Approximately 110 tons will be produced from a 600-ft. face by 16 men, an average of about 7 tons per man shift.

Until recently little attention has been given to the preparation of sizes any place in the field, as only lump has been loaded at the face. The coal is of such hardness that practically no disintegration takes place in transit or in dumping. At the present time some operators are making a fancy lump, a 7 in. x 2½ in. egg, 2½ in. x 1¼ in. nut and screenings.

Nearly all the problems that have arisen in connection with the progress of the field from the old room and pillar solid shooting methods to the present successful conveyor and scow installations have been worked out by local talent. Much progress has been made, but ideal mechanization has not yet been attained. The recovery per man is still unsatisfactory and the overhead costs per ton are too large, due to the small daily tonnage at most of the mines. Some experiments now being conducted are unusual in their conception and will be very interesting if successful. The Paris operators are to be commended for having placed their product in its present enviable position as the highest grade semi-anthracite coal now being produced in the Southwest.

MINING SYSTEM BELL & ZOLLER (From page 619)

the machine to develop its maximum loading capacity that high tonnage and low costs are to be obtained. In order to avoid or reduce as far as possible delays from electrical or mechanical troubles, all machines are given a daily inspection at the end of the shift by the repairmen. At the end of each shift the loading machine and cutting machine operators report to the chief repairman any adjustment or repairs, which, in their opinion, should be made on their machines. These reports are then investigated by the repairman during his inspection.

To obtain the best arrangement of the haulage, so as to eliminate as far as possible the delays due to changing cars, has been a perplexing question. At present, on development work, crossovers are driven from 150 to 200 ft. apart, so that the locomotive does not have to travel over 400 ft. in making a car change. The locomotive, which serves the loading machine, couples to 4 empty cars, and as each car is loaded it is switched into the nearest crossover. The last empty car is left under the loading boom to be loaded while the motorman is getting another 4 empty cars from an outby crossover. Another locomotive brings empty cars from the parting and delivers the loads on to the parting.

In room work the breakthroughs are driven at an angle of 45 degrees with rooms and the track in adjacent rooms is connected through the breakthroughs. As soon as the track connection is made through the first breakthrough, 2 locomotives are used to serve each loader. The 1 motor serves the loader through the room in which the machine is loading, while the other locomotive serves the loader from an adjacent room, through the breakthrough. One car at a time is handled by each motor. And 1 trip rider does the coupling and switchtending for both locomotives; the loading machine helper taking care of the extension rails and the signaling during loading. An average car change of 48 seconds, during the shift, has been possible with this haulage arrangement.

The advancing of the track, laid on steel ties, is taken care of by 1 trackman on each crew. Any assistance which the trackman requires for handling rails is furnished by the timberman. The timberman, in addition to assisting the trackman, sets the necessary props. Another trackman and helper are assigned to three machines to lay the switches.

It was decided to place a foreman in charge of each loading crew, as it was felt that, to a great extent, the degree of success with mechanical loading depends upon the proper planning and managing of the work. Poor supervision is not only costly but will defeat the purpose of mechanical loading. It has been demonstrated that a good foreman is the most productive man in the crew.

The following table shows the results obtained during a representative month's operation:

Machine No.	Driving	8-hr. shifts worked	Avg. tons loaded per shift	Avg. tons per man shift *
1	Entries †	23	229	11.7
2	Entries †	21½	226	12.1
3	Entries †	23	230	13.4
4	Entries †	23	244	13.5
5	Rooms	23	382	19.9
6	Rooms	23	308	18.4

* Including foreman's time, idle day and Sunday work.

† The average feet of development driven per machine for the month was 1,230 ft.

A substantial reduction in accidents in conjunction with a reduction in cost, as compared with hand loading, has been shown. However, against these advantages of mechanical loading, there is the disadvantage of the necessity for larger and more efficient preparation plants or the alternative of reducing the tonnage of the mine to meet the cleaning capacity of the present plant.

STATE REGULATIONS REGARDING ELECTRICAL EQUIPMENT IN COAL MINES

A review of the causes of coal mine explosions in the United States during the fiscal year ended June 30, 1928, made by the Bureau of Mines, disclosed that 14 of 30 mine explosions which occurred were of electric origin. Of a total of 340 fatalities chargeable to these explosions, 282, or 82 percent, are charged against electricity.

In view of this situation, the Bureau of Mines has again examined the various state mining codes with reference to provisions covering the use of electricity in mines. The matter of inspection and maintenance of electrical equipment and circuits was especially considered.

The results of this investigation of state regulations covering inspection and maintenance of electrical equipment in coal mines are given in Information Circular 6108, by L. C. Ilsley and R. A. Kearns, copies of which may be obtained from the United States Bureau of Mines.

A NEW TYPE OF LABORATORY DUST-EXPLOSION APPARATUS

A new type of laboratory dust-explosion apparatus, developed by the United States Bureau of Mines is described in Serial 2927 recently published. Although much valuable work has been done in the study of dust explosions, the laboratory technique has not been developed to the point where the many factors involved can be properly controlled, and thus where really fundamental information can be obtained, state C. M. Bouton, C. H. Gilmour, and Garnet Phillips, the authors. This paper presents a brief discussion of the difficulties encountered in fundamental work on dust explosions, a description of apparatus intended to overcome some of them, and an account of some results obtained.

Long Face Operation with Caving Roof on ROOF JACKS

CONVEYOR mining on advancing longwall has replaced hand loading mine cars in the room and pillar system—Roof caring method with steel jacks supporting the overhang at working face—Sketches show mining plan and photographs illustrate successful roof action

By FRANKLIN BACHE*

FOR many years before the war inflation and up to 1921, the Kali-Inla Mine, at Hartshorne, Okla., had been profitably operated. The general depression in the coal business after 1920, which was much accentuated in the Southwest by the competition of fuel oil and natural gas, greatly curtailed the market and vigorous competition reduced prices and the mine operation lost money.

At the end of 1924 open shop operation had become general in the field and it was possible to seriously consider the introduction of cheaper methods.

Many mechanical room loading and conveying devices were investigated, but in every case the cost of the machinery was out of proportion to the tonnages which could be secured from the short faces of single rooms. And the height was not sufficient for any, then devised, mechanical pit car loader.

The territory is remote from large machine shops. Long-wall operation of various kinds had been tried in the past (but unsuccessfully) at other mines. We desired, if possible, to avoid introducing new machinery and at the same time changing the mining system from room and pillar to a species of longwall. However, it appeared to us that mechanization was not economical in a room and pillar layout in a 4-ft. bed pitching 10 percent, and we concluded that mechanization at this time was not warranted with operation on short faces.

This mine operates the Hartshorne bed which has no partings. Floor hard, roof fair to good, but with local areas of crumbling slick and slided slate and some draw slate. The floor is free from rolls. The mine makes considerable gas and is dusty. Permissible explosives are used.

The mine is 26 years old. It was laid out with the main slope on the pitch operated by rope haulage and by mules in the entries.

Entries were turned across the pitch at 250-ft. intervals on both sides of slope. Rooms were 24 ft. wide with 42-ft. centers and were driven up the pitch and on one side of the entries only. Empty cars were pulled to the face of room by mules, loaded cars were spragged down to the room neck by the miner.

Ventilation is down the slope to the lowest entries where the air is split, going through the air courses of the two lowest entries to the entry headings, thence back to the slope air course by way of the haulage (upper) entry and rooms to the slope air courses, then to the next higher entry, but usually not coming back as far as the slope air courses, being short-circuited into the next air course above through worked out and driven through rooms.

Longwall work is here taken to designate any system of coal extraction in which during first mining no coal is left for roof support except shaft or slope pillars.

The drawbacks to the old longwall methods are various:

Among them was the narrowness of the working space between the coal face and the caved area. In order to minimize the unsupported superincumbent roof strata at the face, the roof was allowed to cave as close to the face as was consistent with sufficient room for a man to work, which was insufficient, however, for any machinery.

The greater the overhang or cornice, of undermined, but not caved roof, the greater the weight on the coal face. A square foot of coal bed normally supports a column of rock 1 ft. square from the top of the bed to the surface, but if some of the coal is mined out, the adjacent unmined coal supports not only the strata vertically over it, but also the weight of the adjacent unsupported strata. When the unsupported strata breaks and drops into the space from which the coal had been removed the extra pressure on the adjacent coal is relieved and the closer the break to the face, the less pressure on the coal and on uncaved roof projecting beyond the face. Therefore it was, and still is, desirable to have the pressure relieved by caving the roof as close to the face as consistent with leaving a cornice or overhang sufficiently wide to permit the operation of mining.

Before mining, loading and conveying machines were introduced, and when mining was done entirely by man power and hand tools, it was only necessary to maintain an overhang sufficiently wide for a man to swing a short-handled pick and to shovel coal along the face to the pit car at the nearest face entry.

But with the introduction of machinery, more space at the face was required and this necessitated the maintenance of a wider overhang and more substantial roof support than for the relatively narrow cornice over the space required for hand labor.

The greater strength and cost of the supports necessary to maintain the wider overhang was economically impossible, unless the supports could be continually withdrawn and re-used as the face was advanced.

This led to the use of so-called "rigid" roof support in longwall panel faces.

This system as used by us up to the present time is not, accurately speaking, a method of absolutely rigid support, because in order to get even bearings for the steel props or jacks, which we use, we place them on wooden blocks and between the top of the jack and the roof we have wooden cap pieces, and consequently lose rigidity in the proportion which the thickness of the wooden blocks and caps bears to the total distance between the floor and the roof. We are considering more rigid substitutes for the wooden floor blocks.

The ideal is to have no break in the overhang in order that its weight will be supported by its attachment to the undisturbed strata overlying the unmined coal. In other words, a cantilever effect. And if we can make our jack support sufficiently rigid, we believe we can closely attain this ideal, which is, briefly, a cornice undetached from the strata above the unmined coal.

We have succeeded over a period of nearly two years and with very tender roof much of the time, in maintaining sufficient space to operate a longwall cutting machine and a jigging conveyor and have advanced two 250-ft. panels over 1,000 ft. each.

Another drawback to the old system was the great number of entries and separate working places which it was necessary to provide. Ordinarily each miner had a certain number of feet along the face allotted to him and called his room, and each room was usually provided with one branch entry. A system which required much entry maintenance, gob walls, cribbing, etc. And the men being distributed around the whole perimeter of the mine, there was no possibility of concentrated haulage or of grouping of the men or of close and effective supervision. These conditions have been to some extent improved by various panel longwall systems, one of which is the subject of this paper.

After thorough investigation of various longwall and mechanical loading schemes we decided to try out, with various modifications, the rigid roof support system then and now in use at the mine of the Valley Smokeless Coal Com-

* President, Kali-Inla Coal Company.

pany near Johnstown, Pa., and have been greatly and unreservedly aided by Messrs. R. Y. Williams and T. M. Dodson of that company.

The plan in general is to advance with a panel 250 ft. wide to the property line pillar, then retreat on a panel of about the same width.

The length of the longwall face is equal to the width of the panel less the space taken by the headings (when any are driven in advance of the face).

The face is cut with a longwall machine, and the double row of jacks are moved up and the coal is shot during the night shift.

During the day shift the coal is shoveled onto the face conveyor and loaded into pit cars, the single row of jacks and the conveyor are moved up.

We prefer a jigging trough conveyor as it can be more easily disjointed and is lighter to handle. It has to be moved up every 24 hours and ease of disjointing and lightness are important. And in low coal the absence of sprocket wheels leaves enough clear height for the coal to pass without taking down roof.

At first we loaded the coal from the face conveyor directly into the pit cars at the lower end of the longwall face. Now we discharge the coal from the face conveyor onto an entry conveyor and thence to the pit cars.

Two plans were considered for the layout of the development and haulage. These were combined and both used during the experimental stage.

The first ("four-entry") plan was to drive double entries with 30-ft. pillars on each side of the panel and to keep them 300 or 400 ft. in advance of the face, the two entries of each pair being connected at intervals of 200 or 300 ft. by diagonal cross cuts for switching cars, so that as the loaded trip was pulled away from the loading end of the face conveyor the empty trip which was standing in the inby end of the loading entry could be moved immediately to the loading point under the discharge of the conveyor with no delay in changing cars. The upper pair of entries were for ventilation and for bringing in props, timbers and other supplies which were easier to handle down the face than uphill from the lower pair of entries.

The second ("two trench") plan eliminated all entry driving. It provided a haulage way for supplies along the upper rib of the panel. And taking up 4 ft. of bottom 7 ft. wide at the lower end of the panel face for a haulage way for coal from the face to the slope parting, 2,000 to 3,000 ft. Both of the haulage ways in the second plan were protected by solid coal on one side only. The other side being protected from the caving by a "timber wall."

With the second plan, as no entry was provided in advance of the longwall face, provision had to be made for switching our 12-car trips near the face. Operating with only one locomotive to each panel, entry partings would have had to be kept close to the face and we did not wish to widen our haulage way, one side of which was protected from the caving by the timber wall only.

It had always been necessary in the mine to brush 18 in. of roof in the haulage entries and about a foot in the rooms to make height for the mules and in order to get a good load on the cars. Sometimes, especially in the rooms, we took up floor instead of brushing the roof. Hence taking up bottom was no new experience in the mine.

On the day shift. Long wall face, shot down coal ready for shoveler, single row of jacks between conveyor and face, conveyor loaded with coal, and double row of jacks

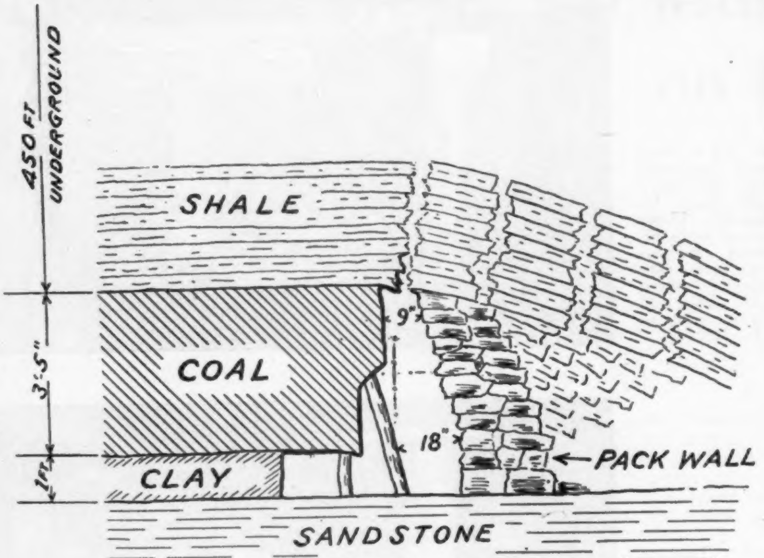
Discharge end of conveyor The conveyor rests immediately on the floor. Cars in 4-ft. trench

Near the end of the day shift coal loaded out ready to move up single row of jacks and the conveyor

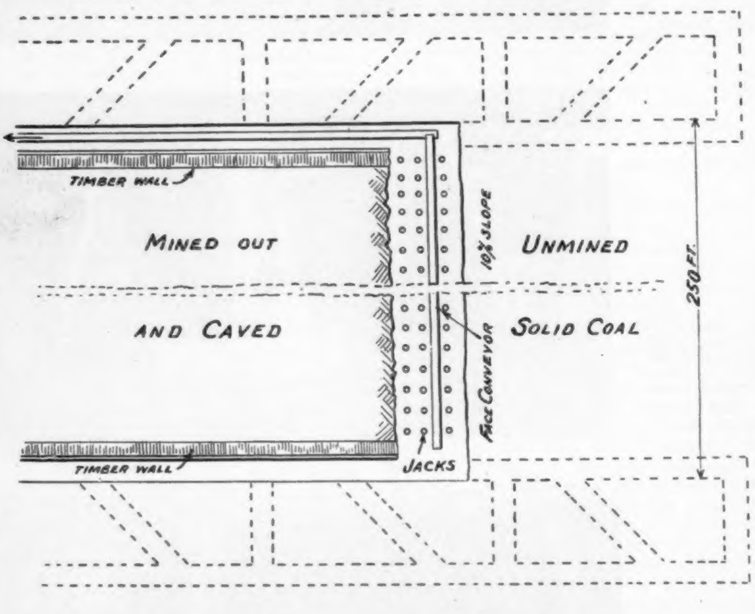
Near the end of the day shift showing double row of jacks and single row partly moved up

Further, it was desirable, even with our first (entry) plan to take up bottom in the loading entry so that the top of the car would be at the level of the bottom of the coal bed in order that the discharge end of the face conveyor would not have to be elevated on blocks (which had to be moved daily) in order to discharge over the side of the car, as it would have had to do if the car stood on the natural floor.

Therefore, as we had to take up some bottom in any case, and it was not a great step to take up 4 ft. intead of, say, 2 ft.

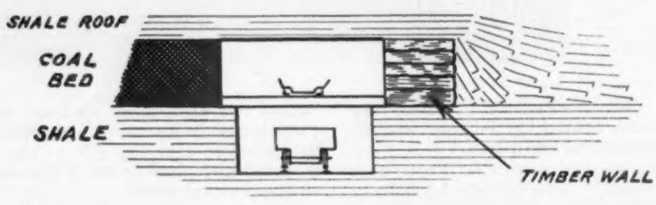


ACTUALLY MEASURED SECTION AT FACE OF NON-RIGID SUPPORT LONGWALL MINE



PLAN OF PANEL — TRENCH SYSTEM

ABANDONED ENTRY SYSTEM SHOWN IN DOTTED LINES



CROSS-SECTION THRO' TRENCH

Then the question arose: Could we hold an entry along each of the two ribs of the panel while we advanced the panel to the boundary at the rate of about 200 ft. a month for about 3,000 ft. or about 18 months? It had to be tried.

With the first plan of double entries on each side of the panel kept in advance of the longwall face a few hundred feet, the entry nearest the face lost its upper rib of coal as fast as longwall face advanced, but we proposed under the first plan to crib this entry sufficiently to insure its maintenance for a few hundred feet outby of the longwall face for car switching purposes.

In order to ascertain by experience how well we could hold this artificial so-called "timber wall" rib and the roof between it and the solid coal rib, we decided that instead of ordinary cribbing, we would carry a solid timber wall 3½ ft. thick. This we did by laying our timbers up like cord wood, piled 4 ft. high (the height of the coal) 3½ ft. through (or wide) and as long as the panel.

We found we could hold this haulage. And that only one such passageway on each side of the panel would suffice so far as ingress, egress and ventilation were concerned. But it did not provide for uninterrupted car service at the face conveyor.

Therefore, until we learned by experience whether or not we could hold the timber wall, trench haulways and safety rely for ingress and egress to and from the face on these roads which were entirely within the mined-out area with roof supported by the timber wall on one side of each passage and by the solid coal bed on the other side and eliminate entry driving, we combined the two plans, both driving the four entries as in the "first plan" and building the solid timber wall and taking up 4 ft. of bottom for the trench as in the "second plan."

When we found that we could safely abandon the entry (first) plan and place our reliance on the trench (second) plan alone, we solved the car service problem in the single track haulway by maintaining an upper deck on the trench entry for about 300 ft. outby of the longwall face.

The motor pulls in the empty trip from the slope parting to the outby end of the double deck, uncouples, runs under the double deck and couples onto the loaded trip; in the meantime a small electric hoist pulls the empty trip up onto the upper deck, over 30-ft. lengths of heavy rails forming a vertical switch. The motor pulls out the loaded trip and goes to the parting at the slope; the empty trip is dropped back on the lower level and pulled up to the face. An entry conveyor on the upper deck as long as our trip, receives the coal from the face conveyor and discharges it into the empty trip. The trip remains coupled and is moved under the entry conveyor discharge by the same hoist that is used to pull the empties onto the upper deck.

We are working under 500 ft. of cover. Each square foot of this to a depth of 500 ft. weighs 40 tons. Each jack has an ultimate resistance to crushing of 550 tons.

In order to provide for the mining machine, the front row of jacks, the conveyor and double row of jacks, we need 10 ft. of cornice or overhang. And after

we undercut the coal to a depth of 5 ft. we have a total of 15 ft. of cornice to support.

This cornice along the 250 ft. length of face weighs 150,000 tons.

We use 180 jacks with a combined ultimate compressive strength of 99,000 tons.

Obviously, the entire dead weight of the superincumbent strata is not supported by the jacks. We have never had any jacks crushed.

We have a rough indicator of the weight on each jack. Tests have been made by the Lorain Steel Company on their hydraulic press and at Lehigh University, under the direction of Mr. T. M. Dodson, with a large testing machine. These tests were made on freshly cut red oak timber such as we use for bottom blocks and cap pieces. The result of the tests was that a piece of red oak 8 in. x 6 in. x 12 in. long placed on top of one of the jacks failed at 97 tons pressure, after being compressed to one-half of its original thickness. A piece of red oak 2 in. thick was compressed to 1 in. at 103 tons and to ⅞ in. at 200 tons. Our cap pieces are rarely crushed to destruction, and the jacks when the face is advancing regularly, rarely carry a load as great as 100 tons each. Taking the estimated actual load on each jack as 100 tons, it would seem that our 180 jacks are only carrying 18,000 tons of the 150,000 tons of the weight of the superincumbent strata. This is 12 percent.

The other 88 percent must be supported by frictional resistance in the cracks between the undisturbed and the broken strata, by a possible advance angle in the line of break and by cantilever action where breaks have not occurred.

With an actual load of 100 tons on jacks having a 550 tons resistance to compression we have a safety factor of 5.5.

Our jacks are made by the Lorain Steel Company, of Johnstown, Pa., and are known as the Langham Jacks. They are cylindrical in cross section, 6 in. outside diameter with walls 1 in. thick. They are made in three parts, viz., top, base and a wedge-shaped middle section. The jacks are squared at the bottom of the base section and at the top of the top section, and these sections are machined at their other ends to the proper angle to correspond to the angle of the center wedge section.

In placing the jack, the base is first set on a wood base block. Then the wedge on it. And the top is then set on the wedge.

A 1-in. bolt goes through the wedge from side to side, an oblong-shaped nut is tightened up and draws the wedge in, forcing the top section of the jack to a firm bearing against the cap piece.

In collapsing the jack, when it is desired to move it forward and when it has taken weight from the roof, the jackman stands a few feet away from the jack and with a steel bar or long-handled hammer knocks the oblong-shaped nut around one quarter of a turn, in which position the nut and wedge are pushed out from between the upper and lower sections, which collapses the jack. As a matter of practice, no pushing is required. The weight of the roof generally pushes it out with a sharp report.

The three sections of the jack are loosely chained together and they are drawn out from under the roof falls with a long-handled steel hook.

The number of jacks required per foot of face, and the practical width of the cornice, is a matter of experiment in any particular mine.

We have learned from our own experience:

First: That under about 500 ft. of cover with a longwall face of about 250 ft. in length, it is practical to maintain a cornice or overhang of the roof parallel to the face of sufficient width to admit the use of a mining machine for cutting the coal and of a conveyor for transporting the coal from all points on the face to the discharge end of the conveyor, permitting in our case 10 shovelers to load out 200 tons of coal per eight-hour shift.

Second: It is not necessary to drive entries either for good ventilation or continuous car service. Passages for ventilation and haulage can be maintained along both ribs of the panel but entirely within the mined out area from the face of the panel to the slope, by carrying a timber wall 7 ft. distant from the upper and lower ribs. These timber walls are strong enough to break the roof on their inner sides; that is to say, on the sides away from the coal ribs and haulways and to secure the roof of the passageways. Thereby adequately providing for ventilation and haulage without entry driving.

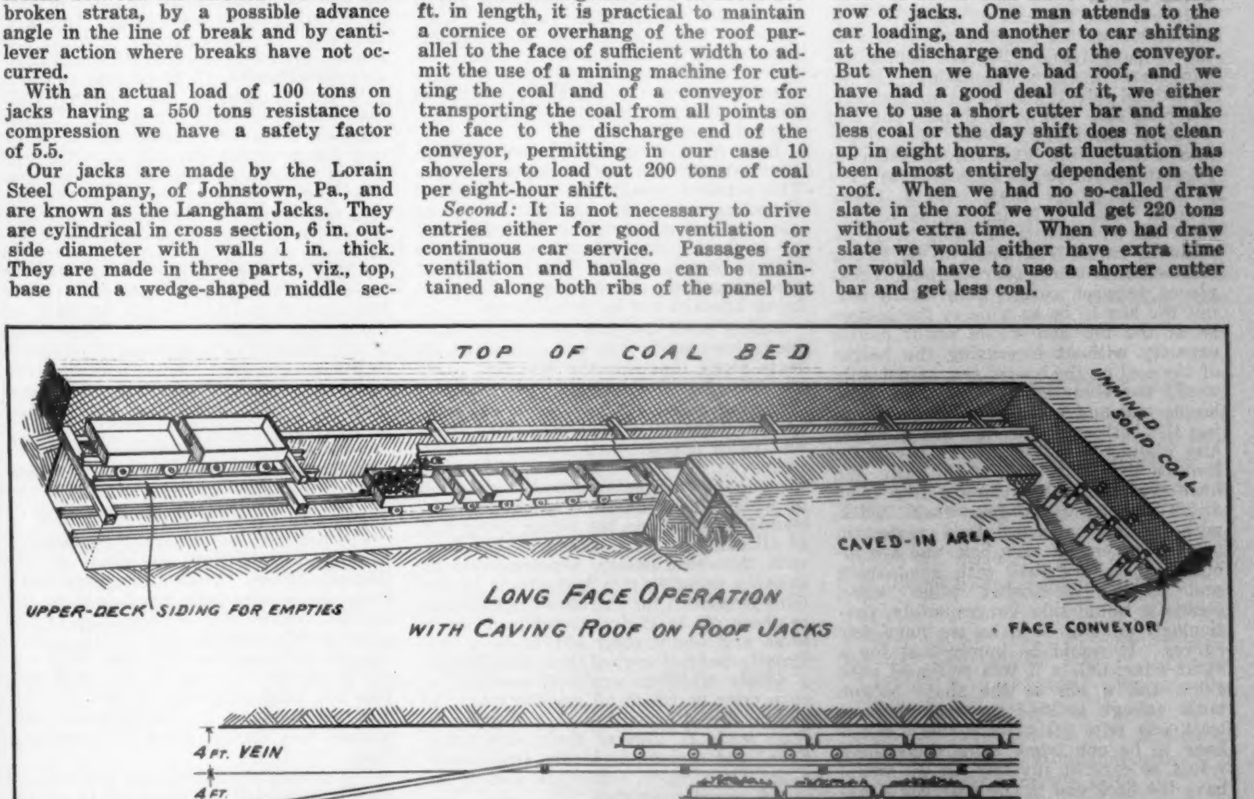
Third: By taking up 4 ft. of bottom in these entries height is provided for switching the empty pit cars over the loaded cars.

Fourth: We found that a timber wall laid up like a pile of cord wood was much stronger in a long unbroken wall than if built crib fashion.

Fifth: We find no leakage of air through the caved area. We have 20,000 cu. ft. and it all goes across the face. The only ventilation difficulty we had was when we were driving the entries in advance of the face.

Sixth: There is no storage place for rock at the face. It all has to be loaded and taken out. Every carload of rock not only reduces the tonnage of coal by one car, but has the additional disadvantage of requiring the coal to be run off the conveyor before any rock is loaded on it. When the roof is good we easily clean up 200 to 220 tons of coal, move up the single row of jacks and move up the conveyor with an eight-hour shift and 10 shovelers.

With a good roof condition we cut the face at night in four hours and with a crew of seven men move up the double row of jacks. One man attends to the car loading, and another to car shifting at the discharge end of the conveyor. But when we have bad roof, and we have had a good deal of it, we either have to use a short cutter bar and make less coal or the day shift does not clean up in eight hours. Cost fluctuation has been almost entirely dependent on the roof. When we had no so-called draw slate in the roof we would get 220 tons without extra time. When we had draw slate we would either have extra time or would have to use a shorter cutter bar and get less coal.



We can handle just about so much material in a shift. If part of it is rock, the coal production is reduced that much and a little more, on account of having to run the coal off the conveyor, and because some of the shovelers would not have any of the rock to move, while others might have a good deal. However, there is usually work for the shovelers when not loading on the conveyor in pulling the coal down and getting it in shape to shovel.

Seventh: We have used both air and electric drills in the coal and in the bottom and prefer the electric drills.

Eighth: We have had endless trouble with conveyor engines, which are not made strong enough for the work. Aside from that, the jigging conveyor is decidedly satisfactory.

Ninth: Placing shot holes has been a problem. If placed near the roof and the coal breaks before they are shot, the shots do little good. While if placed nearer the middle of the face they fail to break the coal sufficiently unless it has broken from the roof.

Tenth: It is noticeably more difficult to drill holes before the coal is cut than afterwards; doubtless because of pressure.

We have not yet mined a retreat panel. We do not think we will develop much greater weight than on the advance, but that is to be learned.

One advantage of the system which we have not yet availed ourselves of is that it would be possible and economical to operate haulage, loading and dumping with the coupled trips of cars as a haulage unit.

In our case the cars do not have to be uncoupled at the loading point, nor at the slope parting. But our tipple arrangement require uncoupling. If we remodeled our tipple so as to use self-dumping cars and so as to pass the trip without uncoupling over the tipple dump, we would have no occasion in regular operation to uncouple the cars at all and could work with a 12-car coupled unit. This has led us to consider the advisability of using boxes instead of cars. The boxes to be swung between four-wheel short-coupled trucks placed between cars. This would permit the box to be as wide at the bottom as at the top and would about double capacity without increasing the height of the coal on the loaded car, as not only would the absence of wheels and axles beside and under the car permit widening the bottom of the car, but it would also allow the bottom of the car to be lowered to within 3 in. of the rail. We have even considered using a two-wheel truck instead of a four-wheel truck, with the axle attached to a projection beyond the end of each box, and are inclined to believe that with good track and possibly somewhat wider wheel treads it would take curves safely, particularly in our case, as we have few curves. It would be impractical for a shaft mine, unless it was equipped with skips and a bin at the shaft bottom large enough to hold the coal from at least one trip. Obviously there would have to be one truck more than there would be cars in any trip, or we would have the back end to the rear box dragging on the rails, and likewise for handling uncoupled cars to the car shop or elsewhere. But in low beds where the system of operation permits the use of trips as units, instead of cars, it is clearly desirable to remove the axles from under the cars and the wheels from beside the cars.

As with any experiment, and particularly in so conservative an industry as bituminous coal mines, the amount of detail we had to work out was very great and the discouragements many.

The operation from its inception has been under the immediate and constant supervision of Messrs. Joseph E. Hendren, superintendent, and William Cameron, mine foreman. Its design was greatly helped by their open mindedness, their valuable suggestions and their constructive criticism. And its successful execution has been almost entirely due to their courage and resourcefulness in meeting and overcoming the almost innumerable difficulties that arose from time to time. It could not have been done with less progressive and open-minded men or by men with less than their great knowledge and experience in coal mining.

MINING METHODS CONSOLIDATION COAL COMPANY

(*From page* 617)

territory under development, proper timbering is very important and to meet the different conditions encountered, timber standards have been drawn up which must be strictly adhered to. Particular attention is given the timbering on pillar work, and regardless of how good conditions may be, the standard timberings made up for more unfavorable conditions is followed out.

There is no doubt but what the use of the timber standards is valuable. Good material is specified, good workmanship insisted upon and sufficient timber required in all cases to meet any ordinary condition, with the further requirement that additional timber is to be set if considered necessary.

Steel for roof support is used quite extensively on the main haulage roads. This consists usually of 5-in. or 6-in. steel H section beams, hitched into the rib at one end and supported at the other end by a short post resting on top of the bottom bench. With this method of timbering there is no danger of the set being knocked out by derailments.

Safety work and safety education have been given much time and study and efforts along that line the last few years are bringing good results.

Mining standards have been prepared for the guidance of the supervisory force, and twice a year each mine is given a rating by the Mine Inspector. This rating is based on the standards, each item of which has a certain charge for substandard conditions, the rating being sum of all charges. It is possible, therefore, with this information, supplemented by monthly reports from inspections by the mine inspector, for the mine organization to check up on their substandard conditions and apply their efforts in a systematic manner toward their elimination.

Safety meetings are held monthly at each mine at which all accidents for the month are discussed and recommendations made to prevent their recurrence. Fatal and serious accidents are investigated by a mine committee and a detailed report submitted.

A central safety committee also meets once a month and is attended by the division officials.

First aid and mine rescue training are a part of the regular safety work. Practically all employes at the mines have had first aid training and a considerable number a thorough training in mine rescue. A competent man is employed for this work and he is also in charge of the mine rescue station which is equipped with breathing and other necessary apparatus.

A safety court, conducted by the workmen, is also held each month and keeps up a great deal of interest in safety work. This court will be described in detail at another session.

RANGE OF DENSITIES IN FLOAT-AND-SINK TESTING OF RAW COALS

In float-and-sink studies of raw coals the importance of separations on the very high and the very low densities is too often overlooked, observes the United States Bureau of Mines. There is a tendency on the part of many companies to use 1 to 3 solutions ranging from 1.40 to 1.60 specific gravity without realizing that the resulting data really throw very little light on the washing problem. If 50 percent of a raw coal is under 1.40 specific gravity, it is of the utmost importance to know whether 5 or 40 parts of the 50 are also under 1.30 specific gravity, and if 40 parts are under 1.30 specific gravity, to know how many parts are also under 1.25 specific gravity. Should it develop that a separation must be made at 1.40 specific gravity to obtain the desired ash content in the washed coal, the company must know the proportion of the raw coal between 1.25 and 1.55 specific gravity; that is, within +0.15 specific gravity of the point of separation, to intelligently interpret the data. If only 5 percent is under 1.30 specific gravity, the separation will probably be difficult. If 30 percent is under 1.25 specific gravity, the washing problem will be greatly simplified. In like manner, it is very important to know how many of the impurities in the coal are of very high specific gravity, say, over 2.00, for this proportion of the raw coal can be safely eliminated from consideration in studying most problems because it may be so easily removed in washing. This subject is covered in some detail in a paper, "Interpretation of Float-and-Sink Data," by B. M. Bird, of the Bureau of Mines, in the Proceedings of the Second International Conference on Bituminous Coal. This paper has been reprinted by the W. S. Tyler Company, Cleveland, Ohio, and copies may be had by writing the company.

WORK OF HOLMES SAFETY ASSOCIATION IN STATE OF WASHINGTON

The broad scope of safety, educational training and welfare activities of the Holmes Safety Association, has been found to be especially applicable to the isolated coal-mining communities of the state of Washington, says J. G. Schoning, in Information Circular 6137, recently published by the Bureau of Mines. The five local chapters of the Association are located at Bellingham, Carbonado, New Castle, Black Diamond and Tono.

The mining regulations for the state of Washington require a mine-safety organization and stipulate that safety committees in which representatives of the employes participate shall make a bimonthly inspection of the mine.

PRODUCTION AND SHIPMENTS OF MANGANESE IN 1928

THERE has been little change in the rate of production and shipments of manganese ore, containing 35 percent and more of manganese, in the United States, in the past three years, according to the Bureau of Mines. In 1928, 46,636 long tons, valued at $1,212,679, was shipped, compared with 44,741 tons, valued at $1,151,918 in 1927, and 46,258 tons, valued at $1,228,663, in 1926. In 1928, 15,430 tons was chemical ore and 31,206 tons metallurgical ore, compared with 17,011 tons of chemical ore and 27,730 tons of metallurgical ore in 1927, and with 19,728 tons of chemical ore and 26,530 tons of metallurgical ore in 1926. It will be noted that there has been a falling off of approximately 2,000 tons a year in the shipments of chemical ore during this period, which is a continuation of the decline from the peak of shipments, 24,637 tons in 1924. Shipments of metallurgical ore were 3,500 and 4,700 tons higher, respectively, than the shipments in 1927 and 1926.

There was an increase of 1,000 tons in the shipments of high-grade ore from Arkansas. Shipments from Georgia rose from 489 tons in 1927 to 4,727 tons in 1928. Idaho shipments decreased largely. The shipments of metallurgical ore from Montana were 12,044 tons in 1928, compared with 10,124 tons in 1927. The plant owned by the Domestic Manganese & Development Co. was put into operation during March and treated rhodochrosite from the Emma mine at Butte, Mont., operated by the Anaconda Copper Mining Co. It produced 11,118 tons of calcined and nodulized material containing 56.45 percent of manganese. In 1927 the larger part of the metallurgical ore shipped from Montana was from mines at Philipsburg. High-grade shipments from New Mexico and Virginia increased somewhat and those from Nevada dropped off entirely.

The figures on shipments of manganese in Alabama, Georgia, North Carolina and Virginia were collected in cooperation with the State Geological Surveys.

The imports of manganese ore in 1928 totaled 427,708 tons, containing 207,808 tons of manganese, and valued at $5,395,949, compared with 622,067 tons, containing 308,630 tons of manganese, and valued at $8,487,016. There were large decreases in imports from all of the important producing countries.

The record production of steel in 1928, 51,544,180 long tons, indicates a record demand for ferromanganese and consequently for manganese ore. The domestic shipments of ferromanganese, 310,122 tons, were the largest on record, with the exception of those for 1926, and indicated a consumption of approximately 620,000 tons of manganese ore. The domestic production of manganese ore has changed little in the past three years. Assuming that the metallurgical manganese ore produced in the United States in 1928 offset the ore imported for chemical uses, the total quantity of ore imported, 428,000 tons, was available for consumption in the manufacture of ferromanganese. This tonnage is 192,000 tons less than that required by the manufacturers of ferromanganese in 1928. The difference is explained largely by the decrease in stocks in bonded warehouse, officially reported as 183,477 tons of manganese content on December 31, 1927, and 114,497 tons on December 31, 1928, a difference of 68,980 tons of manganese content, equivalent to at least 138,000 tons of ore. The remainder of the ore required, approximately 55,000 tons, may have been taken from stocks at the plants of consuming companies.

MANGANESE AND MANGANIFEROUS ORE (EXCLUSIVE OF FLUXING ORE) SHIPPED FROM MINES IN THE UNITED STATES IN 1928, BY STATES (LONG TONS)

State	Ore containing 35 percent or more of manganese			Ore containing 10 to 35 percent of manganese			Ore containing 5 to 10 percent of manganese		
	Number of shippers	Shipments	Value	Number of shippers	Shipments	Value	Number of shippers	Shipments	Value
Metallurgical									
Alabama	2	*	*	..	......	......	..	......	......
Arizona	5	3,507	$35,500	1	214	*	..	......	......
Arkansas	6	3,623	81,862	4	7,136	$43,880	..	......	......
Colorado	..	......	......	4	18,599	99,823	..	......	......
Georgia	1	4,727	*	8	4,687	41,322	..	......	......
Idaho	2	*	*	..	......	......	..	......	......
Massachusetts	..	......	......	1	*	*	..	......	......
Michigan	..	......	......	2	7,943	*	1	41,261	*
Minnesota	..	......	......	1	*	*	5	1,025,014	$2,471,582
Montana	3	12,044	*	1	*	*	..	......	......
New Mexico	3	2,627	*	2	36,250	*	1	19,081	*
North Carolina	1	10	*	..	......	......	..	......	......
Tennessee	2	55	*	5	718	6,778	1	45	*
Utah	..	......	......	1	286	*	..	......	......
Virginia	9	2,847	47,932	1	35	*	..	......	......
Undistributed	..	1,766	426,093	..	14,843	215,086	..	......	173,583
	34	31,206	591,387	31	90,711	406,889	8	1,085,401	2,645,165
Chemical									
Montana	†2	14,689	621,292	..	......	......	..	......	......
Virginia	1	741							
	3	15,430	621,292	..	......	......	..	......	......
	37	46,636	1,212,679	31	90,711	406,889	8	1,085,401	2,645,165

* Included under "Undistributed."
† Mills through which all shipments were made. Individual producers not counted.

MANGANESE ORE IMPORTED INTO THE UNITED STATES, 1927-1928 *

Country	1927			1928		
	Ore	Manganese content, long tons	Value	Ore	Manganese content, long tons	Value
Africa (British):						
South	....	....	....	5	3	$73
West	87,230	42,172	$478,214	24,186	11,712	145,059
Brazil	174,026	78,602	1,584,836	142,300	64,290	819,615
Canada	430	228	9,660	3,929	2,234	101,422
Chile	3,206	1,470	36,054	....	....	....
Colombia	....	....	....	9,340	4,423	118,208
Cuba	8,976	4,211	141,836	3,180	1,556	60,402
Germany	65	37	4,331	138	68	8,007
India (British)	93,017	47,863	1,185,610	83,600	43,072	1,037,942
Java and Madura	1,527	863	42,276	1,026	792	26,580
Russia in Europe	253,544	133,159	5,000,279	159,842	79,529	3,067,259
United Kingdom	46	25	3,920	167	129	11,382
	622,067	308,630	8,487,016	427,708	207,808	5,395,949

* According to the Bureau of Foreign and Domestic Commerce.

ALUMINUM SALTS IN 1928

The production of aluminum salts in the United States in 1928 was 386,905 short tone, valued at $13,990,264, an increase of 8,135 tons, or 2 percent in quantity, but a decrease of $298,166, or 2 percent in total value, as compared with 1927, according to a statement of the United States Bureau of Mines.

The makers of aluminum salts consumed 83,067 long tons of domestic bauxite and 58,243 tons of imported bauxite, a total of 141,310 tons, valued at $1,842,224 at consuming works. There were also consumed 458 tons of alumina and 5,158 tons of aluminum hydrate in the manufacture of the salts.

Exports of aluminum sulphate from the United States in 1928 were 22,713 short tons, valued at $552,342.

International Smelting Acquires Holdings of Knight Investment Co.

The vast holdings of the Knight Investment Company, in the Tintic District of Utah, totaling over 9,000 acres, have been taken over by the North Lily Mining Company, subsidiary of the International Smelting Company. The deal was the outcome of negotiations that have been in progress for several months by J. O. Elton, general manager of International Smelting's Utah enterprises, and president of the North Lily Mining Company.

Under the terms of the contract made by J. William Knight, president of the Knight Investment Company, and North Lily, all of the Knight properties will pass to a new corporation to be known as the North Lily-Knight Company, with a capitalization of 3,000,000 shares and also 100,000 shares of North Lily stock as a treasury asset.

The properties embraced in this transaction comprehend 6,159 acres of patented mining claims, 349 acres of unpatented mining claims, surface rights to 1,739 acres and a contract on 880 acres—a total of 9,127 acres of ground. The individual properties involved include control of the Twentieth Century, Big Hill, Empire Mines, Dragon Consolidated, Eureka, Swansea, Middle Swansea, Swansea Consolidated, Tintic Drain Tunnel and substantial interests in Tintic Central, Southern Eureka and North Godiva.

According to announced plans of the North Lily management the first move in development of the Knight properties, and the financing of which is guaranteed by dividends on the North Lily stock which goes to the new organization—providing at least $100,000 a year for three years—will begin at once on the Twentieth Century ground, located on the north side of the Iron King mine and embracing geological and structural features southwest of Tintic Standard similar to those of the North Lily, northwest of the Tintic Standard. The surface of the Twentieth Century is said to be one of the most highly altered areas in the Tintic district. The Ophir formation, which is the bonanza ore-bearing horizon of the East Tintic district, dips through this property.

The final rounding out of this momentous transaction makes the International Smelting Company—Utah unit of the Anaconda Copper Mining Company—one of the largest mining and smelting units in the state and the west. Aside from their newly acquired properties, the company owns other large acreage in the Tintic district, approximately 6,000 acres in the Park City district, which is now under development, and big producing mines in the camp of Bingham.

Agreement Ends Chief Consolidated—Mammoth Fight Over Ore Accounting

Thirty years of litigation between the Chief Consolidated Mining Company and the Mammoth Mining Company was officially brought to a close the latter part of June, when the two concerns signed an agreement resulting in a dismissal in the United States Supreme Court of a petition for a rehearing.

The celebrated case was begun in 1899, when the Grand Central Mining Company brought suit against the Mammoth Company for an accounting of ores taken from the Grand Central property, and to establish boundary lines between the two properties in the Tintic mining district of Utah.

After the inception of the suit the Grand Central was taken over by the Chief Consolidated Mining Company, and the latter company was substituted as plaintiff. The Plutus Mining Company, controlled by the Chief Consolidated, is included in the settlement.

Last November the United States Circuit Court of Appeals ruled that the Mammoth Company was liable for an accounting of the ores taken from the adjoining Chief Consolidated properties.

By the terms of the compromise agreement, vertical lines are to be established between the Chief Consolidated and Mammoth properties and between the Plutus and the Mammoth. Each company is to pay its own costs and fees, and neither side is to recover damages.

Canam Metals Purchases Golden Hawk Mines

Purchase of the two properties of the Golden Hawk Mining Company by the Canam Metals Corporation was announced recently by C. W. Nicolson, manager of the Canam. No consideration was made public, but it is understood that the properties were valued at more than $250,000.

The Golden Hawk Company owned the old Golden Rod No. 5 and the Black Hawk mills and leases, the leases each consisting of 40 acres.

The addition of the two properties to the Canam group gives that company ownership of 10 properties. The company first purchased the five mills of the Childress Lead and Zinc Company for a consideration around $1,000,000. Later the Foch mine was purchased and then the Tri-State and Crystal. The company, before the recent acquisition of the Foch, Tri-State and Crystal mines, was the eighth largest producer of lead and zinc in the Tri-State district.

Montana Manganese Plant Increases Output

The Domestic Manganese & Development Company, of Butte, Mont., is now producing 225 tons of roasted manganese ore daily, according to John H. Cole, president of the company. The plant is roasting "pink" manganese ores from the Emma mine of the Butte Copper & Zinc Company, a subsidiary of the Anaconda Copper Mining Company, and shipping high grade "black" product to eastern steel mills. The company recently made a contract to ship part of its product to the plants of the Colorado Fuel & Iron Company.

Consolidated Mining & Smelting to Build $7,000,000 Fertilizer Plant

The Consolidated Mining & Smelting Company will spend approximately $7,000,000 in building a fertilizer plant at Trail, British Columbia, which incidentally will handle all the smelter fumes and end the damage which has caused protests from residents of Stevens County, Wash., just across the line. The first unit, utilizing 30,000 hp. and extracting nitrogen from the air, will require about two years to build.

PREPARATIONS BEING MADE FOR SPOKANE MEETING OF AMERICAN MINING CONGRESS, WESTERN DIVISION

Preparations are being made by the American Mining Congress for the annual meeting of its Western Division at Spokane, Wash., from September 30 to October 5. At the same time meetings will be held by the Northwest Mining Association, the American and Canadian Institutes of Mining and Metallurgical Engineers, and the Mining Bureau of the Spokane Chamber of Commerce. A feature of the convention will be a visit by the delegates of the various organizations to the mining region of Coeur d'Alene, Idaho, October 4 and 5.

The first session of the joint conventions of the mining organizations will be held by the Northwest Mining Association on September 30. The sessions of the Western Division of the American Mining Congress will be held October 1 and 2. Stanly A. Easton, vice president and general manager of the Bunker Hill and Sullivan Mining and Concentrating Company of Kellogg, Idaho, will preside as chairman of the morning session October 1. At this meeting an address is expected to be made by Robert E. Tally, of Clarkdale, Ariz., general manager of the United Verde Copper Mining Company, on the work of the American Mining Congress, of which he is president, in behalf of the metal industry. James F. Callbreath, secretary of the American Mining Congress, will give a review of the legislative situation in Congress as affecting the metal mining industry, at the afternoon session, October 1. The coal resources of the Northwest will be the subject of an address by George Watkin Evans, consulting mining engineer of Seattle. The program on October 3 will be in charge of the American and Canadian Institutes of Mining and Metallurgical Engineers. On October 4 the delegates will leave for Kellogg and Wallace, Idaho, for a trip through the Coeur d'Alene mining district, and on October 5 will visit the Hecla and Starr mines.

Frank M. Smith, of Spokane, director of the Bunker Hill smelter of the Bunker Hill and Sullivan Mining and Concentrating Company, is chairman, and Leon Starmont, also of Spokane, is secretary of the Western Division and are making arrangements for speakers and entertainment features for the convention.

Kansas Adopts Metal Mining Code

A set of rules to govern the inspection of metal mines in the State of Kansas were approved at a meeting held the latter part of July, Fred Nesbitt, safety engineer of the Tri-State Zinc and Lead Ore Producers' Association, announced at Picher, Okla.

Mr. Nesbitt and A. Scott Thompson, legal advisor for the association, represented the mine operators, and C. J. Beckman, commissioner of labor and industry, and James Sherwood, chief mine inspector, represented the State of Kansas.

There is no metal mining code in Kansas. The commissioner of labor and industry has supervision over all places where persons are employed, which gives him supervision over the metal mines.

The code of rules prepared by Commissioner Beckman and approved at the conference, follow closely the new metal mining code recently passed by the Oklahoma Legislature, with some changes in the phraseology. Commissioner Beckman realized that most of the metal mines of the state are adjacent to the Oklahoma-Kansas lines, and in many instances companies that operate in one state operate in the other, which would tend to make conditions practically the same in both states, making the Oklahoma law applicable to conditions in Kansas.

Morenci Branch Holds Lead in Phelps Dodge Safety Contest

Three branches of the Phelps Dodge Corporation, Morenci, Stag Canyon and Old Dominion, turned in perfect safety records for the month of June, with no lost-time accidents occurring in any of the three branches' departments.

The Morenci Branch held the all-time record of the corporation's different branches for five consecutive months, until in May, when one accident, which necessitated lost time by an injured employe, lowered its standing to give the lead to the Copper Queen for that month. Morenci went into the lead column again in June, followed by the Stag Canyon Branch in New Mexico and the Old Dominion unit at Globe.

Only six time lost accidents were chalked up against the other two branches, two against the Moctezuma Copper Company of Nacozari, Mexico, and four against the Copper Queen Branch of Bisbee.

A marked reduction in the number of time lost accidents since the contest was launched a few years ago among the four mining branches of the Phelps Dodge Corporation is noted from month to month. The annual report at the close of 1928 revealed the strides that have been made in the reduction of the time lost accidents and in inculcating enthusiasm among the workers regarding safety practices and in competing with workers of the other branches for the honor of standing at the top of the safety contest.

The Morenci Branch has a strong lead in the contest for the year to date with a percentage of .005 figured on the basis of one time lost accident.

The Moctezuma unit of Nacozari is in second place with eight time lost accidents, a percentage of .026, figured on the basis of 1,000 shifts worked, and the Copper Queen in third place with a score of .032, having had 16 time lost accidents. The Old Dominion, with eight accidents in the year to date, is in fourth place with .061 and the Stag Canyon with 12 in last place with .111.

Inspiration Acquires New Properties in Miami District

The Inspiration Consolidated Copper Company has acquired for $500,000 the Southwestern Miami Development Company, whose properties adjoin those of Inspiration in the Miami district of Arizona.

New N. J. Zinc Secretary

A. P. Cobb has resigned his position as secretary of the New Jersey Zinc Company and has been succeeded by R. G. Hudson. Mr. Cobb continues as a vice president of the company. Mr. Cobb has been in ill health the past year, which accounts for his resignation as an active official.

Zinc Cartel Agreement Extended for Year

It is announced in the European press that the zinc cartel has now been formally extended for a year, beginning on July 1. So far as production limitation is concerned, the following basis has been agreed upon: (1) When the price of zinc reaches £27 per ton, or exceeds it, no limitation of production by the members is to apply unless the increase in production, in relation to the average production, of the last three months exceeds 10 percent. (2) If the price of zinc does not reach £27 and if the European stocks simultaneously amount to 30,000 tons or more, then limitation of production comes into force automatically.

CALIFORNIA NEWS ITEMS

Governor Young will appoint a mining commission of five men to advise with the Director of Natural Resources on mining matters. According to unofficial rumors two of these commissioners will come from southern California, one from the Mother Lode region, one from the extreme northern counties and one from San Francisco.

The Walker copper mine in Plumas County shortly will increase the capacity of the flotation plant from 1,200 to 1,600 tons daily. Production for the past two months has reached $280,000, with ore averaging a little better than 2 percent copper.

The old French Hill hydraulic mine in Del Norte County is being reopened, and water will be turned in about August 1, according to C. P. Terwilliger, president and manager. Five miles of ditch has been constructed and 1,500 ft. of 15-in. pipe with a 165-ft. fall installed. Two giants will be used, with 2,000 miners inches of water available. This property has a production record of $2,000,000 and the ground is said to average 30 cents a yard.

Litigation has broken out between the owners and the operators of the Boundary mine in Grass Valley and the rich specimen ore uncovered a month ago has been seized by attachment of the owners pending the outcome. Owners are suing for $100,000 damages and $100,000 in royalty payments claimed due.

North Fork placers, 18 miles west of Weaverville, is running two giants and employing 50 men. A new flume is being built to tap the north fork of the Trinity for more water to enable larger operations.

A group of 640 acres of claims covering the extensive deposits of pumice in the Glass Mt. area of Siskiyou County has been sold to a Berkeley firm by J. O. Miller, E. L. Jameson, and D. A. Williams of Mount Shasta.

Another large hydraulic mine operation is forecast in the sale of the McGilvray property on the Trinity River to Earnest Dickson, Robert Stanley, N. P. Olsen and George Herron. A high ditch will be constructed from Conner Creek with a head of 300 ft. and a 15-in. giant, pipe and other equipment are being moved from the Red Hill mine.

Gordon Bettles, in behalf of the Yellow Tiger Consolidated, has acquired control of the Gray Eagles mine east of Downieville and now has a crew at work cleaning out and prospecting for ore bodies. This is the fourth property opened up by Bettles in the last two years and all are proving successful.

NORTHWEST MINING NOTES

Mining in the Inland Empire has not been in a more flourishing condition since the war than it has been in the first six months of the year, according to reports from Spokane. In the Coeur d'Alenes in particular there is more activity, a heavier production, more men employed, and more mining enterprises being developed. Dividends of the district are higher for the last six months than they were for the first half of last year. There is far more mining in Washington than there has been in years. The Metaline district is employing more men and is the outstanding district of the state. British Columbia mining is going on at a fast pace, with thousands of men employed. Dividends have increased in this province as they have in the Coeur d'Alenes.

Operation of the concentrating mill of the Grandview mines at Metaline Falls, Wash., was resumed recently. It was closed down for a few weeks while the ball mill was being relined. More drill holes have been put down at the scene of a recent discovery, which is reported to have added importantly to the known resources of the property.

Stoping has been started from the 1,200 level in the Tamarack mine in the Coeur d'Alenes and the ore is reported as much as 7 ft. wide. The drift on this level in the ore has been continued for about 200 ft. and the ore in the face is 6 ft. wide, of unusually high-grade mill feed, with considerable of the product sufficiently rich to stand shipment without milling, there being a good deal of ore that tests 36 percent lead, 18 ounces of silver and 10 percent zinc.

According to C. C. Samuels, manager of the Sunshine Mining Company on Big Creek, Coeur d'Alene region of Idaho, the capacity of the mill of the company will be increased to 185 tons soon. This will be brought about when the installation of 10 cells of Minerals Separation is completed.

Lead and zinc concentrates from the Hall-Interstate mine in Valley County, central Idaho, are now being received at the Bunker Hill smelter and the Sullivan electrolytic plant, both at Kellogg, Idaho. This Valley County mine was recently taken over by the Bunker Hill Company, which has developed it and put in operation a mill of 250 tons daily capacity. The company is now having installed a second hydroelectric power plant at the Hall-Interstate mine.

Control of the Marsh Mines Consolidated, a responsive property at Burke, Idaho, passed to the Hercules Mining Company recently. The acquisition of control was brought about by the purchase of the treasury shares and a large block of stock acquired previously. The price was not announced, but reported to have involved about $100,000 for the treasury shares, according to an authoritative statement. The payment was cash.

MINE PRODUCTION OF GOLD, SILVER, COPPER AND LEAD IN CALIFORNIA IN 1928

(In terms of recovered or recoverable metal)

Advance figures compiled by the United States Bureau of Mines

County	Number of operations Lode	Placer	Ore * Short tons	Gold Fine ounces	Silver Fine ounces	Copper Pounds	Lead Pounds	Total value
Alpine	1	...	5	1.13	621	....	3,000	$560
Amador	13	12	408,045	108,211.10	24,473	1,400	....	2,251,441
Butte	5	35	1,752	2,342.90	1,246	....	....	49,161
Calaveras	23	25	10,754	7,854.75	2,511	132,532	2,800	183,088
Del Norte	...	1	....	13.38	2	....	....	278
Eldorado	26	33	14,029	5,902.56	1,191	1,040	....	122,864
Fresno	1	3	10	747.63	128	....	....	15,530
Humboldt	...	8	....	86.48	12	....	....	1,795
Imperial	2	...	4	1.20	2	219	....	58
Inyo	25	...	4,343	521.54	40,937	21,547	1,744,782	139,029
Kern	19	2	30,235	9,019.65	8,966	....	....	191,698
Lassen	3	...	37	23.78	14	....	....	500
Los Angeles	3	1	260	105.79	34	....	....	2,207
Madera	5	3	325	173.18	246	15,170	....	5,908
Mariposa	19	7	9,932	5,832.48	3,759	....	....	122,767
Merced	...	3	....	14.98	3	....	....	312
Mono	4	...	11,303	305.09	301,052	....	....	182,422
Nevada	16	34	219,264	96,459.83	35,552	....	....	2,014,800
Placer	6	38	2,392	3,481.03	578	....	....	72,297
Plumas	10	36	750,988	16,091.17	326,725	21,140,975	....	3,568,068
Riverside	3	...	177	105.47	2,672	12,263	98,911	11,246
Sacramento	...	12	....	75,376.64	3,041	....	....	1,559,952
San Bernardino	24	5	48,400	4,436.81	620,070	109,885	38,544	472,517
San Diego	4	4	428	129.19	22	....	....	2,684
San Luis Obispo	...	3	....	35.09	2	....	....	726
Shasta	13	22	135,050	5,472.76	67,403	3,055,570	3,000	592,739
Sierra	11	30	31,796	32,646.13	6,176	....	....	678,468
Siskiyou	14	65	2,127	4,146.57	719	....	....	86,138
Stanislaus	...	6	....	9,466.17	950	....	....	196,239
Trinity	9	46	18,519	19,480.33	20,954	660,142	....	510,012
Tuolumne	26	7	1,551	1,780.55	316	....	....	36,992
Yuba	2	19	815	111,474.23	8,394	....	....	2,309,287
Total, 1928	287	460	1,702,541	521,739.59	1,478,771	25,150,743	1,891,037	15,381,783
Total, 1927	318	465	1,526,410	564,585.50	1,620,242	27,133,008	2,718,014	†16,881,362

* Includes 122,684 tons of tailings.
† In 1927 California produced 8,062,625 pounds of zinc, valued at $516,008.

Calumet and Arizona Plans Vast Expansion and Modernization Program

Expenditure of more than $2,000,000 for construction of new units and expansion of present plants of the Calumet and Arizona Mining Company in Bisbee and Douglas, Ariz., has been authorized by the board of directors, according to announcement made by Harry Clark, general manager.

Approximately $1,700,000 of the total $2,133,000 authorized in expansion and modernization program of the company will be expended on the Douglas Smelter plant of the C. & A. and includes enlargement of the roaster plant, installation of complete new reverbatory furnaces with a new charging and skimming track system and a new convertor plant, along with additional power units.

Plaster model of the late General John C. Greenway, which will be cast in bronze and placed in Statuary Hall in the Capitol Building at Washington, D. C. The figure stands seven feet, eight inches in height, and is an informal study of General Greenway, the famed and beloved Arizona miner, engineer and soldier who died the early part of 1926. Incidentally, it is the first statue to be placed in the National Hall of Fame by the State of Arizona.

Underwood & Underwood

Electrification of the Junction shaft equipment, which includes the installation of a new electric hoist, replacing the present steam hoist is embraced in the project and will require $533,000 of the total improvement expenditures. In addition to the new hoist at the Junction, the company plans to install two electric air compressors, two combustion water tube boilers with a capacity of 750 hp. each, one 750 kw. steam turbine with cooling towers and additional buildings.

This latest project to be launched by the Calumet and Arizona Mining Company is among the largest announced by mining companies in Arizona in recent years and follows the consolidation of the C. & A. with the New Cornelia Mining Company of Ajo. It follows on the announcement of several months ago projecting the development of the Campbell shaft, which included the purchase and installation of a new double drum electric hoist, buildings and equipment in addition to development of the shaft and cementing of Saginaw shaft which is to be used for ventilation purposes.

A total of $1,750,000 will be expended in enlarging and modernizing the C. & A. smelter plant at Douglas, and it is hoped to have the first unit of the new plant in operation by the first of next year. Two items are concerned in the smelter program, it was stated. One is to handle the increased ore production expected from the Bisbee mines of the company and the new Cornelia property at Ajo.

Another object of the modernization program is to prepare the smelter to handle anode copper, which will be shipped to the new refinery at El Paso, Tex. In the past the copper ore smelted at Douglas has been produced as blister copper and shipped to the Perth Amboy refinery in New Jersey.

The anode plant will consist of two 100-ton tilting type anode furnaces with casting well and other necessary equipment.

Three new reverberatory furnaces will be installed to replace the four now in use. The new ones of the latest improved type. Three Pierce-Smith convertors will replace the six Great Falls type convertors now in use.

Quincy Mining Company Remodeling No. 6 Hoist for Deeper Shaft

Hoisting has been temporarily discontinued in No. 6 shaft of the Quincy mine to permit of the remodeling of the hoist. A smaller, over-winding drum will be installed, which will increase hoisting capacity to 13,500 feet, equivalent to that of No. 2. The speed and load of the two hoists will be the same, each lifting a 10-ton skip. While hoisting in No. 6 has been suspended while the changes are being made, there will be no cessation of development work in the bottom of the shaft, rock from which will be hoisted through No. 2.

The increased capacity of No. 6 hoist will make possible an additional 4,500 feet in depth, both Nos. 2 and 6 shafts now being bottomed on the ninetieth level. Since the reopening of No. 6, this unit has been sunk 400 feet from the eighty-sixth. Nos. 2 and 6 are being kept at equal depth.

Nearly 20,000 Men Employed in Mines, Smelters of Arizona

According to the Arizona Industrial Congress, approximately 19,200 men are on the pay rolls of the larger mining and smelting companies in the state, or nearly 5,000 more men than were employed one year ago, the number at that time being 14,300. The report also states that an estimated 2,500 men, in addition to the above figures, are employed in the smaller mines.

This increase in working forces has also raised the monthly pay roll from $2,000,000 a year ago to $3,000,000 at the present time, and based on the present price of copper, wages are 15 percent higher than they were on October 1 last.

According to the best estimates obtainable, metal production is considerably higher at present than a year ago. Unofficial figures place copper production at around 75,000,000 pounds a month at the present rate, while average monthly production last year was about 61,356,933 pounds. Production of gold and silver has increased in like degree, it is indicated, lead remaining practically the same.

Eight Tri-State Go Six Months Without a Lost-Time Accident

Eight mines in the Tri-State district have worked the first six months of 1929 without a time-lost accident, according to records kept by the safety department of the Tri-State Zinc and Lead Ore Producers' Association. Seven of these properties belong to the Commerce Mining and Royalty Company and the other to the Evans-Wallower Lead Company.

The mines follow:

Grace Walker, Jay Bird, Scammon Hill, Wilbur, Webber, Gosling and Paxson of the Commerce Company.

Mine No. 24 of the Evans-Wallower Company.

Robert E. Tally, president of the American Mining Congress and general manager of the United Verde Copper Co., New York, has been elected Arizona vice president of the American Arbitration Association.

The new Old Timers' Building at Rock Springs

"OLD TIMERS" MEET IN WYOMING

OLD timers and new timers had a big get-together at Rock Springs, Wyo., July 19 and 20 at the fifth annual reunion of the Old Timers' Association, sponsored by the Union Pacific Coal Company and the Washington Union Coal Company.

First aid contests were held July 19, and the following day marked the dedication of the new Old Timers' Building, presented to the association by the Union Pacific Coal Company, and a banquet early in the afternoon, preceded by a parade.

Hanna No. 1 team, of the Union Pacific Company, took first place in the first-aid contest, with an average of 197¼. The members of this team are Ted Attryde (captain), Thomas Lucas, Arnum Bailie, John Fermelia, W. H. Moffitt and Charles Mellor. Superior No. 1 captured second place, averaging 195, and Reliance No. 2 was award third place with an average of 193¼. In all, 11 teams participated, and the lowest score was 180½.

The winning team of the first aid miners were presented with the contest cup, held for one year by the Tono, Wash., team, and which will now rest at Hanna, Wyo., for one year. Each member of the winning Hanna team received $30 in gold. The second and third teams receiving $20 and $10 to each individual. The presentation was made by President Eugene McAuliffe.

Twenty-three boy and girl scout teams from various parts of the state held their contest in the morning of the same day.

The team from Hanna No. 1 Mine, winners of the first-aid contest

The Old Timers' Building which was dedicated July 20 was just recently completed. The Old Timers' Association is composed of men who have worked 20 years or more for the Union Pacific Coal companies, and now numbers close to 450. The banquet was preceded by a parade, led by McAuliffe's Pipe Band.

McAuliffe's Pipe Band

George B. Pryde, vice president and general manager of the Union Pacific Coal Company, officiated at the banquet, and addresses were made by C. B. Huntress, assistant to the secretary of the National Coal Association, and John P. White, former president of the United Mine Workers of America, and now labor referee for the operators and miners of Wyoming.

Part of Mr. Huntress' address follows:

"Of all hosts for such a great gathering of real folk, none could fill the role with more genuine understanding than the president of the Union Pacific Coal Company and related companies. * * *

"You people have developed communities as well as coal properties. Yours is a record of progress and it is natural that progressive people should band together in good fellowship, thereby renewing, as your articles of association say, and thereafter maintaining, the friendship of earlier days in an annual get-together meeting. Reaching the goal is not the big thing in life; the things that one meets by the way are the things that count. Such meetings as this fifth annual reunion make life worth while. * * *

"This building, beautiful in its material aspects, is still more beautiful from a symbolic standpoint. It signifies a new spirit in industry."

Mr. Huntress paid tribute to Eugene McAuliffe, president of Union Pacific, describing him as "a man who knows the economic value of industrial friendship, a man who knows the need of faith in men, a man who makes men while he produces coal. It has properly been said that all human progress is far less a course of events than a procession of colorful personalities. This surely applies with relation to the progress that has been made in this land under the leadership of men who commanded the confidence of a pioneering people."

CENTRAL PENNSYLVANIA HOLDS GALA MEET AT EBENSBURG

The week of July 1 will long be remembered by Central Pennsylvania operators, having marked the Fifth Annual Cambria County Industrial Exposition, at Ebensburg, climaxed on Saturday, July 6, with the Pennsylvania state championship first aid and mine rescue contest and the fourth annual summer meeting of the Central Pennsylvania Coal Producers' Association.

Better than 250 members of the coal association and visitors attended the operators' meeting, 33 teams represented their companies in the first aid meet, and 38 manufacturers of mining equipment had their displays in the mining exposition hall.

The team from the Nemacolin mine of the Buckeye Coal Company carried off first honors in the first aid and mine rescue contest with an average of 99½ percent, and was awarded the Charles M. Schwab trophy. Mr. Schwab presented the trophy personally. Second place went to the Consolidation Coal Company team from Mine No. 120, Acosta, Pa. These men gave the winners but very little margin of victory by making a score of 99¼ percent. William Nesbit, of Greensboro, Pa., president of the Coal Mining Institute of America, presented a plaque to the second team on behalf of his organization. Honorable mentions were accorded the teams of the Pittsburgh Terminal Coal Corporation from Coverdale, Pa., and the Allegheny mine of the Pittsburgh Coal Company, from Parnassus, Pa.

Mr. Schwab highly commended the various teams for their splendid showing and urged them to seek the highest perfection possible. "That should be the real aim of every man in life," he said. "Whatever you have to do, whatever your job may be, you should do your very best to see how well you can do it. However humble it may be, do it better than the other fellow and you have done the best that any man can do."

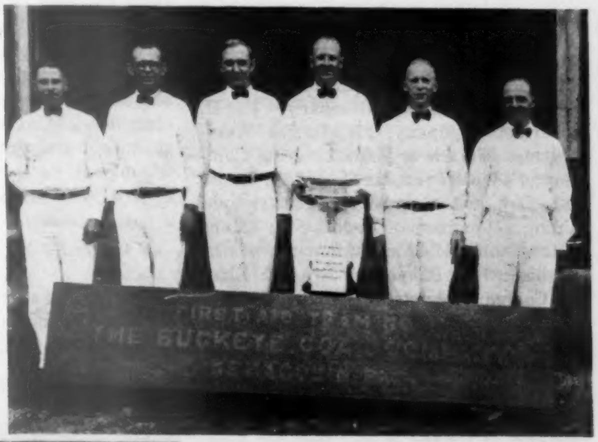
Mr. Schwab expressed his appreciation of the work done by those concerned with the meet, particularly mentioning H. D. Mason, Jr., consulting engineer of Ebensburg, and secretary of the Coal Mining Institute of America, who acted as master of ceremonies.

A large number of operators and guests participated in the annual golf match between the eastern and western shlope operators, played at Immergrun, Mr. Schwab's private course, and at the Cresson Summit Club. The western slope team was captained by C. Law Watkins, vice president of the Pennsylvania Coal & Coke Corporation, and the eastern slope team by G. Webb Shillingford, general manager of the Empire Coal Mining Company. The match was won by the eastern team with a total of 161¾ points against 157¾ scored by their opponents. Prizes were awarded to the individual golfers, both operators and guests.

Coal mining men from all fields of the state as well as from West Virginia, and officials from the traffic, operating and purchasing departments of several railroads, attended the meeting of the Central Pennsylvania Coal Producers' Association. The banquet was held in the evening of July 6, with B. N. Clark, of Indiana, Pa., president of the association, as toastmaster. Harry L. Gandy, executive secretary of the National Coal Association, spoke on the problems of the industry, and urged a closer fraternal spirit among those engaged in the industry for the solving of their problems. F. E. Herriman, president of the Clearfield Bituminous Coal Corporation, spoke on the subject of consolidation, making som evaluable suggestions along the line of combining smaller units with the larger ones. Other speakers included Mr. Clark, Judges J. H. McCann and F. P. Barnhart, of the Cambria County Courts; Walter Glasgow, chief of the state department of mines; and Charles O'Neill, secretary of the association. W. E. E. Keopler, secretary of the Pocahontas Coal Operators' Association, bespoke the good wishes of the West Virginia operators.

The Coal Mining Institute of America held its meeting Friday evening, July 5, in connection with the exposition, attended by about 200 mining engineers and geologists. Among the speakers were George H. Ashley, state geologist of Pennsylvania; James R. Campbell, Koppers-Rheolaveur Company; William M. MacGillivery, Dow Chemical Company; and Oscar Cartlidge, consulting engineer.

A demonstration of the explosibility of coal dust and the effectiveness of rock dust for checking such explosions was put on twice daily throughout the week by representatives of the United States Bureau of Mines in a specially constructed gallery. This feature was in charge of R. E. Currie, associate mining engineer, and G. N. McLellan, fore-



Buckeye No. 1 team, Pennsylvania first-aid champions. Its members are G. A. Walters, captain, Barney Syredinsky, Russell Harris, Otis Wilson, George Shiffbower and Frank Kapriva

The mining exhibits are shown below

man miner of Car No. 3, both of the Pittsburgh Station of the bureau. The coal dust explosion was made using about 100 lbs. of Pittsburgh dust, ignited by means of a blown out shot of black blasting powder. Following this, the shot was fired into a 65 percent mixture of rock dust, making a convincing and practical demonstration.

The exhibits of 33 manufacturers of mining equipment made an impressive display and proved an interesting attraction for the coal operators. The following companies were represented:

Brown-Fayro Company, Johnstown, Pa.; Loraine Steel Company, Johnstown; Timken Roller Bearing Company; Ohio Brass Company; Gellatly & Company (representing also E. I. duPont de Nemours Company, Post Glover Electric Company and Simplex Wire & Cable Company); Dow Chemical Company, Midland, Mich.; Harris Pump & Supply Company, Pittsburgh; Jeffrey Manufacturing Company, Columbus; Mine Safety Appliances Company, Pittsburgh; Chicago Pneumatic Tool Company; National Carbide Sales Corporation; Brookville Truck & Traction Company; Warner Laboratories, Cresson, Pa.; Pennsylvania Electrical Repair Company, Pittsburgh; Bethlehem Steel Company; Bertrand P. Tracy Co., Pittsburgh; South Fork Foundry & Machine Company, South Fork, Pa.; Crawford Machinery Company, Pittsburgh; Ideal Commutator Dresser Company; Martin Hardsocg Company, Pittsburgh; Goodman Manufacturing Company; H. H. Robertson Company, Pittsburgh; Westinghouse Electric & Manufacturing Company; DeWalt Products Company, Leola, Pa.; Sun Oil Company; Pennsylvania Mining Machinery Corporation; Manhattan-Stone Machine Company, Hollidaysburg, Pa.; Flood City Brass & Electric Company, Johnstown; General Electric Company; Mosebach Electric & Supply Company, Pittsburgh; Jos. Dixon Crucible Company, Jersey City; Condon Bearing & Supply Company, Pittsburgh; Penn Machine Company; Jas. T. Castle, Pittsburgh; United Wood Treating Corporation.

Alabama Holds Banner Safety Day

Teams of the DeBardeleben Coal Corporation carried off three first prizes and two second prizes in the Eleventh Alabama First Aid Contest, held in Birmingham, July 6, under the auspices of the Alabama Mining Institute, the U. S. Bureau of Mines and several other organizations. Thirty-three teams took part in the meet, which was marked by high scores and extremely close competition as indicated by the scores of the first and second prize-winners in the contest between the teams. The Sipsey team of the DeBardeleben Coal Corporation scored 97.6-plus, as against the score of 97.6-minus of the team of the Newcastle Coal Company. A beautiful prize in the form of a silver plaque was donated by the National Coal Association, to the first prize-winner.

Gold medals went to each of the teams making the highest scores and, in addition to individual prizes, the Alabama Mining Institute will present a framed certificate to each mine winning first and second place in the contest. The Alabama Power Company furnished the judges for the occasion and N. L. Muir, of the U. S. Bureau of Mines, presented the prizes.

Coal Classification Report

Dr. Henry Mace Payne, consulting engineer to the American Mining Congress, has completed his report on marketing practices, trade names, analyses, sources and uses of the coals of Virginia, North Carolina, Georgia, Kentucky, Tennessee, and Alabama. It will be submitted to the Sectional Committee on Classification of Coal, acting in cooperation with the American Society for Testing Materials, the American Mining Congress, the American Institute of Mining and Metallurgical Engineers and other interested technical and professional bodies, these states having been assigned to Dr. Payne for report. The Sectional Committee will work out and recommend to the coal trade generally a plan for the classification of coals based on their chemical and physical characteristics which may be readily adapted to the industrial and commercial use of coal on a national scale.

Interior Department Amends Coal Lease Regulations

The Interior Department has amended the regulations governing bonds under coal mining leases and permits. The old regulations required a bond of $10,000 to assure expenditure of the amount of the investment and another bond of $5,000 after the investment had been made, to assure compliance with the lease. The new regulations provide that if more than $10,000 is to be invested under the lease, a bond of that amount shall be posted. After the investment has been made a $5,000 bond may be substituted for the $10,000 bond. In the case of a small area where the investment will be less than $10,000, the bond to cover the investment and compliance with other terms of the lease shall equal half the amount of the investment, but not less than $1,000. On filing an application for a coal prospecting permit a $500 bond must be posted. A $1,500 bond will be required where the permit covers land entered or patented with the coal reserved under the act of June 22, 1910, or where any part of the land is in a reclamation project, to protect the coal deposits from damage and to assure the area being left in a safe condition on termination of the permit.

Ohio Appoints Mine Safety Engineer

The Ohio Industrial Commission has extended the service of the Division of Safety and Hygiene to include the mining industry of the state by the creation of the position of mine safety engineer. The plan of the division is to carry on an educational safety program into the mines in a similar fashion to that carried in other industries. The mine safety engineer will carry on his work in a purely advisory capacity, making safety surveys, organizing safety programs, addressing safety gatherings and acquainting operators and miners with the services of the department, which are to be given without cost.

Lewis C. Lewis has been named to the position. He will have his headquarters in Columbus in the Division of Safety and Hygiene. Mr. Lewis has had extensive experience both as a practical miner and has been in close contact with the operating end of the business.

Anthracite Freight to New Jersey Called High

An Interstate Commerce Commission examiner on July 26 reported to the commission that he had found freight rates on anthracite in carload lots from Pennsylvania to destinations in New Jersey were unreasonable.

The examiner recommended that the rates in general should not exceed $2.39 per ton on prepared sizes of coal and $2.27 on pea and smaller sizes.

The complaint was brought by the Central New Jersey Coal Exchange against the Central Railroad Company of New Jersey.

Map Out Program for Improving Ohio Industry

A joint committee of operators and state officials appointed following a conference of operators representing a large proportion of Ohio's coal output, has outlined a two-year program for improving the coal industry of Ohio and place it back, if possible, in the position it occupied prior to the World War.

The committee met in Columbus recently and the program was approved by unanimous vote of the members. The Department of Mining Engineering at Ohio State University has been enlisted

in the work and an appropriation has been secured from the board of control.

In addition to the committee headed by E. W. Smith, chief of the Mines Division of the Ohio Department of Industrial Relations, a number of the professors of the Department of Mining have been enlisted in the work. A survey of the industry from the standpoint of marketing, preparation and freight rates will be made. The committee members consist of George M. Jones, Jr., vice president of the Ohio Colliery Company, Toledo; William Emery, Jr., president of the Cambridge Collieries Company, Cambridge; H. L. Findlay, vice president of the Youghiogeny & Ohio Coal Company, Cleveland; R. L. Ireland, general manager of the Wheeling & Lake Erie Coal Company, Cleveland; and W. E. Tytus, president of the Sunday Creek Coal Company, Columbus, representing operators, and Prof. H. E. Nold, of the Department of Mining Engineering; Prof. D. J. Demorest, Department of Metallurgical Engineering; Prof. F. W. Marquis, of the Department of Steam Engineering; and Prof. J. M. Weed, of the Engineering and Experiment Station, all of Ohio State University, representing the technical staff.

The survey to be made by the technical staff will include analysis of coals from Ohio and regions in direct competition, a study of mining conditions with reference to reducing the cost, and a survey of shipping and traffic conditions.

West Virginia Coal and Coke Reorganization Plans Announced

Plans for the reorganization of the West Virginia Coal and Coke Company, purchased July 9 by bondholders of the concern for $1,500,000 at a Federal court sale have been announced by John C. Cosgrove, one of the Federal receivers, who will be president of the new company.

The new concern, which will be known as the West Virginia Coal and Coke Corporation, will have a capital of $2,400,000. Cosgrove said rehabilitation of all operations at a cost of approximately $1,000,000 was planned. Modern machinery will be installed in all mines and coal preparation plants and mining camps will be overhauled.

A. H. Crane, of New York, who was secretary-treasurer of the old company, will hold that position with the reorganized concern. Operating officials will also remain unchanged, J. W. Bischoff, superintendent of operations continuing his headquarters at Omar.

The new company will have an authorized issue of $5,000,000 first mortgage 5 percent 20-year bonds, of which $2,000,000 will be issued shortly. The company will have an authorized issue of common stock of 750,000 shares of no par value, of which 552,007 will be issued shortly. The capital of $2,400,000 will cover improvements to properties, expenses of reorganization and will provide working capital. The money will be provided from the sale of $2,000,000 in bonds and 48,000 shares of common stock.

Philadelphia & Reading Acts on Power Project

That the Philadelphia & Reading Coal and Iron Company plans to enter the electric power-production field in the anthracite districts was indicated recently with the filing of charter papers at Harrisburg, Pa., for 33 electric companies to operate in 33 townships in the state.

The proposed electric project will be financed by a new electric holding company, yet to be chartered, and it is understood that plans for financing the company, including an issue of bonds, have been discussed with bankers. The holding company's stock will be owned by the coal company.

Present plans of the management of the Philadelphia & Reading Coal & Iron Company in connection with the electric project have not been disclosed in their entirety. It is understood, however, that the plans provide for the using of steam-size coal at the power plant, which is to be erected close to the Reading Company's mines. This is the size of coal that is produced in large quantities by all of the large anthracite producing companies, and which has felt most keenly the competition of coal substitutes in the eastern industrial markets.

Through the erection of the power plant the coal company will be able to generate sufficient power for its own needs at a comparatively low production cost and have sufficient plant capacity to sell surplus power to the companies operating in the electric light and power field in and around the hard coal fields.

The Stone & Webster Engineering Corporation had recommended, upon completion of a survey, the expenditure of more than $19,000,000 by the coal company for the electrification of its collieries, etc., this figure including the erection of a power plant.

The incorporators of the companies for which charters have been asked, and on which action was to have been taken July 24, all are officers of the Philadelphia & Reading Coal & Iron Company. They are:

Martin P. McDermitt, secretary; Perley Whitaker, controller; and Francis H. Maloney, assistant to the president.

Twenty of the companies for which charters are sought will be located in municipalities in Schuylkill County, 10 in Northumberland County, two in Dauphin County, and one in Columbia County, as follows:

Barry, Eldred, Lykens, Hubley, Tremont, Frailey, Reilly, Foster, Cass, Butler, Mahanoy, Jackson, Jordan, Washington, Upper Mahanoy, West Mahanoy, Zerbe, Coal, Conyngham, Hegins, Porter, Mount Carmel, Little Mahanoy, East Cameron, West Cameron, Mifflin, Branch, New Castle, Norwegian, North Manhemin, Blythe, Ryan, Norwegian and East Norwegian. The name of the township as well as "Reading" are contained in each corporate title.

It is stated in the charter notice that the companies are to be formed for the purpose of supplying light, heat and power, or any of them, by means of electricity to the public in the townships enumerated.

William B. Wilson Appointed Arbitrator for Illinois Association

William B. Wilson, Secretary of Labor for eight years during the administration of President Woodrow Wilson, has been jointly selected as arbitrator by the Illinois Coal Operators' Labor Association, which represents the coal producers in the State of Illinois and District No. 12, which is the Illinois organization of the United Mine Workers of America.

This announcement was made July 4 by President Joseph D. Zook, representing the coal operators, and President Harry Fishwick, representing the miners, with the following statement: "Under the joint wage contract adopted last September by our respective organizations it was agreed that one man would be selected to arbitrate disputes arising under the contract which might fail of settlement through the regular channels as provided for in the contract.

"In the selection of Mr. Wilson it is our belief that we have secured a man with a background of experience and unquestioned integrity, who is well qualified for this important work because of his experience in the coal industry for many years.

"It is believed that in this selection the coal operators of Illinois and the United Mine Workers of America have taken a step of national importance. It is also believed that this action will have a far-reaching influence and promises to further promote the stabilization of the industry itself and is an additional guarantee to the consumers of Illinois coal that their sources of supply from Illinois mines will be uninterrupted. With such an arrangement for the final disposition of disputes the suspension of operators by illegal strikes should be largely, if not entirely, eliminated.

"Although Mr. Wilson's present home

is in Pennsylvania, it is agreed that he will make his headquarters in Illinois in order that he may be in close touch with the situation with which he has to deal."

Hillman Coal & Coke Buys Thompson No. 1 Mine

The Thompson No. 1 mine, owned by the Redstone Coal & Coke Company, has been sold to the Hillman Coal & Coke Company. The mine, one of the largest in the Uniontown, Pa., district, increases the operations of the Hillman interests in Fayette County to 10.

Employing 250 men, the Thompson No. 1 mine is now operating, and has been shipping coal for several years.

A joint survey is being conducted by both companies to ascertain the exact acreage to be assumed by the new owners.

The Hillman Coal & Coke Company has not decided whether they will continue to raise coal at the Thompson No. 1 mine or whether they will bring it to the surface at the Thompson No. 2 mine, which is also owned by the company.

Hudson Coal Appoints Fillmore Sales Agent

George B. Fillmore, of Scranton, assistant general sales agent of Hudson Coal Co. since 1921, has been appointed general sales agent to succeed the late Ralph W. Clark, who died in Scranton July 4.

Mr. Fillmore has been employed by the Hudson Coal Co. since January, 1919, first associating with the company as an engineer. In August of the same year he was promoted to chief coal inspector, a position he held until his promotion to assistant general sales agent in 1921.

West Virginia Mines Make Safety Records

Mine 15, at Stirrat, W. Va., and the Norton mine have established new safety records for the year and what may be all-time records for any West Virginia Coal and Coke Company mine when both operated for nearly 40 days without a single mishap.

Since June 12 Mine 15 has not had a single accident and the record for Norton shows that not a single accident has occurred since June 15.

The other mine at Stirrat, Mine 19, has a record which nearly equals her sister mine at Stirrat and the northern mine with only one accident this month. Approximately 600 men are employed at the three mines.

COAL PRODUCTION BY STATES

Statistics and interesting sidelights on coal production in the various states are being issued by the Bureau of Mines. Production reports for states other than the ones given below are soon to be issued.

Pennsylvania

PENNSYLVANIA continues to lead all other states in the total value of coal production, according to the latest figures compiled by the United States Bureau of Mines. The total value of the coal produced by the mines of the state in 1928 was $643,533,000; of this, $393,-638,000 was contributed by the anthracite mines and $249,895,000 by the bituminous mines. In comparison with the year preceding the total value shows a decrease of 7 percent and the total tonnage a decrease of 3 percent.

The production of bituminous coal was 131,202,163 tons. Fayette County continued to lead all other bituminous counties in the state with a total production of 29,564,000 tons. Next in order came Westmoreland County with 16,729,000 tons, Cambria County with 15,012,000, Washington County with 14,776,000, and Allegheny County with 13,393,000 tons.

In comparison with 1927, the record for 1928 shows a tendency to concentrate production of bituminous coal in a smaller number of more efficient mines. The number of commercial bituminous mines in operation declined from 1,831 to 1,557, but the number of Class 1 mines, that is, mines producing 200,000 tons or more, increased from 174 to 189. The output per man per day increased from 4.26 tons to 4.52. A smaller number of men were employed, but those remaining on the pay rolls were given more steady employment. The total number at work declined from 153,829 in 1927 to 133,414 in 1928, but the average time worked by the mines in operation increased from 203 days to 218 days.

The year rr1928 was one of lessened activities in the bituminous coal industry, and Pennsylvania operators shared the general countrywide conditions. The average price f. o. b. mines in 1928 was $1.90 per ton, or 25 cents less than in 1927.

Indiana

BITUMINOUS coal production in Indiana during 1928 amounted to 16,-378,580 net tons. Compared with the output in the previous year this is a decrease of 8.7 percent. The decline centered in Knox, Pike, Sullivan, and Vigo Counties, most of the other producing counties showing an increase.

A striking feature of coal production in Indiana is the steady increase in the output per man per day. A decade ago the average output per man-day was 4.45 tons, while in 1928 it had risen to 6.51 tons, an increase of over 46 percent. This large gain is explained by two factors; the very great increase in the quantity of coal mined from strip pits and the rapid advance of mechanization in the deep mines of the state. In 1918 only 4.8 percent of the coal output of Indiana was produced by stripping operations, while in 1928 these mines accounted for 29 percent of the state's production. The progress made in the mechanization of coal mines in the state is indicated by the fact that Indiana ranks second only to Wyoming in the percentage of its deep mined output handled by loading machines or conveyors.

The total value of the coal produced in Indiana in 1928 was $29,212,000, or an average value of $1.78 per ton. In 1927 the average value per ton was $2.03. There were 16,806 men employed in the coal industry of the state in 1928, as against 24,352 men in the previous year. The average number of days worked was 150 compared with 120 days in 1927.

Wyoming

PRODUCTION of coal in Wyoming during 1928 amounted to 6,571,683 net tons. In comparison with the 6,-753,656 tons produced in 1927, the figures for 1928 show a decrease of 2.8 percent. The interesting feature of the statement is, however, the high output per man per day that has been attained in Wyoming.

Since the introduction of mining machines in the coal fields of Wyoming the average number of tons produced per man-day has been steadily mounting and in 1928 reached 6.34 tons. This compares with an average of 4.69 tons a day in 1920 when the first mining machines began to appear in the state. In Sheridan County, Wyoming, which has been particularly amenable to machine mining, the average output per man in 1928 reached the high point of 12.89 tons per day, as against an average of 4.55 tons for all bituminous mines in the United States in 1927.

Incidentally, the tonnage produced by mechanical methods in Wyoming in 1928 ranked second only to that of Illinois. Of the 6,572,000 tons produced last year, 2,682,000, or 40.8 percent, was mined mechanically.

New Mexico

PRODUCTION of coal in New Mexico during 1928 amounted to 2,711,-851 net tons, a decrease of 7.6 percent, compared with 1927.

The greater part of this decline is accounted for by the reduced output in both Colfax and McKinley Counties, the two principal producing counties in New Mexico. Rio Arriba County and the local commercial mines of San Juan County show a substantial gain in coal production. Colfax County, however, still remains by far the most important coal producer in the state, accounting for 61.3 percent of the total output, while McKinley County ranked second producing 28.4 percent of the total.

The total value of the coal produced by the mines in New Mexico in 1928 was $8,636,000, or an average value of $3.18 per ton, which was slightly higher than that of 1927 when the average value was given as $3.13 per ton. In 1928 there were 3,441 men employed in the coal industry of the state as compared with 3,456 men in the previous year. The average number of days worked in 1928 was 213 as against 251 days in 1927.

Michigan

MICHIGAN'S quota of the coal output of the country in 1928 was 617,342 net tons, a decrease of 18.4 percent from 1927, and the smallest tonnage accounted for by the state since the turn of the century. Although not ranked as one of the larger coal mining state, Michigan is a regular producer of bituminous coal. The coal mining industry of the state has in recent years experienced the same conditions that have held down bituminous production in the country generally.

The total value of the coal produced last year amounted to $2,631,000, or an average value of $4.26 per ton, which was slightly less than that of 1927 when the average value was given as $4.31 per ton. In 1928 there were 1,239 men engaged in the industry, of which 1,119 were employed underground and 120 on the surface. The total number of workers employed in coal mining the year before was 1,512. The average number of days worked in 1928 was 187, as against 188 days in 1927.

American Standards Association and Bureau of Standards Establish Cooperative Agreement

A cooperative agreement between the American Standards Association and the United States Bureau of Standards to encourage national standardization activities in industries has been ratified by Dr. George K. Burgess, Director of the Bureau, and the board of directors of the association of which the American Mining Congress is a member body. Under the terms of the agreement, the primary effort of the bureau will be to serve industrial groups which have no satisfactory standardization facilities, the bureau helping such groups to formulate temporary standards to meet immediate requirements. The A. S. A. will work primarily with those bodies having standardization facilities and will bring together such groups for the formulation of "American standards" which represent a true national consensus of approval. Where feasible, temporary standards, prepared with the aid of the Bureau of Standards, will also be brought before the association for advancement to the rank of "American standards."

The text of the agreement follows:

1. The American Standards Association is the agency through which standardization by trade associations, technical societies, and governmental agencies is advancing in the United States on a broadly national scale. The association is maintained by a group of national organizations, industrial, technical, and governmental (at present 40 in number).

2. The association imparts a definite status to standards which are prepared by industry in accordance with the association's procedure, through declaring them American standards, after a consensus has been reached among the various groups substantially concerned—producers, consumers, distributors, and general interests.

3. The National Bureau of Standards, through its Division of Trade Standards, is acting as a centralizing agency for industrial and commercial groups requesting its cooperation in the adjustment, application, and promotion of standards that will facilitate production and marketing of the commodities which concern the requesting group. After proper acceptance of such standards by the interests immediately concerned, the bureau publishes them as the "commercial standards" of those interests. Primarily, the effort of the bureau is to serve those groups which have no satisfactory standardization facilities.

4. Since "commercial standards" are obviously of interest to groups immediately concerned with the manufacturing and marketing of specific commodities, such standards are not considered to have the same status as is imparted to standards approved as American standards by the A. S. A., though it is hoped that some commercial standards will eventually receive such approval. Commercial standards are temporary standards.

5. In the advancement of commercial standards to the status of American standards, the Bureau of Standards may serve as the sponsor for a given project if it shall appear that such sponsorship is desired by the proponent group and if such assignment is consistent with other sponsorships and with the regular practice and procedure of the A. S. A.

6. With reference to changes or revisions of a standard for which the bureau acts as sponsor, the bureau will, under the A. S. A. procedure, in the same way as other sponsor organizations, assume responsibility for presenting the proposed changes to the proponent group for consideration and action.

7. The foregoing does not apply to simplified practice recommendations since the bureau endeavors to keep the elimination of unnecessary varieties a separate function.

The first board of directors of the American Standards Association, provided for in the association's new constitution, has just been completed. It is given complete control of the general policies and finances of the association and includes nine members, designated for a period of three years by the member-bodies of the association, in addition to the president, vice persident, and junior past president of the association. The members of the board are as follows:

Quincy Bent, vice president of the Bethlehem Steel Company, in charge of manufacture, representing the American Society for Testing Materials; Dr. George Kimball Burgess, Director of the Bureau of Standards, representing the Department of Commerce; Cloyd M. Chapman, vice president of the American Standards Association; Clarence L. Collens, designated by the National Electrical Manufacturers Association, president of the Reliance Electric and Engineering Company of Cleveland; Howard Coonley, designated by the American Society of Mechanical Engineers, president of the Walworth Manufacturing Company of Boston; L. A. Downs, representing the American Railway Association, president of the Illinois Central Railroad; Bancroft Gherardi, vice president and chief engineer of the American Telephone and Telegraph Company, representing the American Institute of Electrical Engineers; F. E. Moskovics, designated by the Society of Automotive Engineers, president of the Improved Products Corporation, investment bankers, of 44 Wall Street, New York City; William J. Serrill, president of the American Standards Association, chairman of the research committee of the United Gas Improvement Company; C. E. Skinner, assistant director of engineering of the Westinghouse Electric and Manufacturing Company and chairman of the American Engineering Standards Committee from 1925 to 1928; Matthew S. Sloan, designated by the Electric Light and Power Group, president of the New York Edison Company and its affiliated electrical companies; Robert J. Sullivan, representing the A. S. A. safety group.

Industrial Development Conference

Those interested in the varied wealth of southern mineral resources and their future development will find much of interest in the report of the proceedings of the Industrial Development Conference held by the Southern Division of the American Mining Congress at Atlanta, Ga., April 11 and 12 last. The proceedings have been published in an attractive volume of 142 pages, copies of which may be obtained on application to the American Mining Congress, 841 Munsey Building, Washington, D. C.

The report contains the verbatim official transcript of the entire proceedings of the conference, including the prepared addresses, the discussion from the floor, and the debate on numerous resolutions on policy which were considered by the conference. The proceedings are interspersed with facts, figures, information, wit, humor, and valuable suggestions for an intensive development of a southern mineral empire. Resolutions of the conference and addresses by the delegates on mineral tariffs are of special interest, because of the forthcoming consideration by the Senate of the revised tariff bill. Another public question reviewed is the Mississippi River Flood Control program in its effect on southern mineral resources, including the natural gas and oil fields in Louisiana. When Congress reconvenes agitation will be renewed for modification of the Jadwin plan to meet these and other objections.

Students of economics as well as captains of industry will find much of interest in the addresses delivered at the conference, notably those of B. G. Klugh, of the Federal Phosphorus Co., on "The Value of Research in Industry"; W. L. Churchill, industrial economist of New York, on "Profits, the Basis of All Industrial Progress"; Gov. Eugene R. Black of the Federal Reserve Bank of Atlanta, on "Opportunities for Young Men in the South"; Dr. Thorndike Saville, of the North Carolina Department of Conservation on "The Relation of Topographic Mapping and Water Resources Investigations to the South's Industrial Progress"; and James H. Skewes, editor of the Meridian, Miss. "Star," on "The South, The Promised Land of Opportunity."

WITH THE MANUFACTURERS

Jeffrey Manufacturing Company, Ltd., Recently Incorporated In Canada

The Jeffrey Manufacturing Company, of Columbus, Ohio, has announced the incorporation of the Jeffrey Manufacturing Company, Ltd., at Montreal, Quebec. This new Canadian company has its head office and works in Montreal, a branch office in Toronto, and a mining supply warehouse in Calgary, Alberta.

The complete line of Jeffrey chains, portable loaders, elevating, conveying, pulverizing, crushing and mining machinery which for more than 50 years has been manufactured at Columbus, Ohio, will in the future be supplied by the new Canadian company.

The Jeffrey Manufacturing Company, of Columbus, Ohio, recently acquired the Galion Iron Works and Manufacturing Company, of Galion, Ohio, which is one of the largest and oldest manufacturers of road machinery, including a full line of gasoline and steam road rollers, leaning wheel road graders, tractor power graders, road drags and road plows. This company also manufacturers cast-iron and special non-corrosive galvanized culverts. In addition to the Jeffrey line, it is the intention of the Jeffrey Manufacturing Company, Ltd., to supply the complete line of Galion machinery from its Canadian plant.

The officers of the Jeffrey Manufacturing Company, Ltd., are: R. W. Gillispie, president; R. H. Ross, treasurer and manager; and F. N. Diehl, secretary.

Westinghouse Appoints New Section Engineer

The Westinghouse Electric and Manufacturing Company has appointed H. Speight to the office of section engineer in charge of electro-chemical and electro-metallurgical work in the general engineering department. Mr. Speight is a native of England. He began his engineering career as a mechanical engineer with the British Westinghouse Company, now the Metropolitan Vickers Company. Later he was with the Poole Dryer Corporation, of Vancouver, British Columbia. This company did consulting engineering work on metal mining hydroelectric generation of power and on large pumping properties. Leaving this position Mr. Speight became associated as an electrical engineer with the Granby Consolidated Mining, Smelting and Power Company in whose services he remained for 10 years. The last five years he served as power superintendent. All electrical work in their mining, by-product coke plant, concentrator, and smelting operations of the metal mining industry came under his supervision.

Three and one-half years ago Mr. Speight came with the Westinghouse Company and during this entire period has been in the mining section of the general engineering department. His experience here included application of hoists, locomotives, pumping and power problems. During the last year he has spent a great deal of time in the anthracite field working with the engineers of the various mining companies on the general problem of electrification. Mr. Speight is a member of the A. I. E. E. and the A. S. M. E.

New Gardner-Denver Drill Sharpener

New in the mining field is the model DS-3A double cylinder small drill steel sharpener just placed on the market by the Gardner-Denver Co., of Denver, Colo. Low air consumption and unusual power are two of the oustanding points of this machine. It is only 44½ in. high and has a base diameter of 24 in. Weight is 1,500 lbs.

Front view of the new DS-3A drill sharpener manufactured by the Gardner Denver Co. at its plant in Denver, Colo.

This new drill sharpener is equipped with two vertical cylinders which give it extraordinary power and rapid speed of operation. The upper piston is utilized independently in forging operations and the lower piston is brought into play only when clamping. Both cylinders, however, are used in clamping, thus giving it added clamping power.

This machine will forge bits and shanks and sharpen section drill steel not exceeding 1¼ in. in diameter and not requiring a bit of more than 2½ in. in diameter.

It forms lug shanks on 1, 1⅛ and 1¼ round steel and makes collared shanks of 3¼ and 4¼ in. on ⅞ and 1 in. hexagon or quarter-octagon steel.

The Gardner-Denver Co. has two main plants, one in Denver and the other in Quincy, Ill. Its principal products are air compressors, slush and mud pumps, high pressure drill forges and drill steel sharpeners.

The New York office of the Hardinge Company has been moved from 120 Broadway to the Chanin Building, 122 East 42nd Street.

Link-Belt Company Issues New Crane Book

Link-Belt Company, of Chicago, Ill., has issued a 48-page book, profusely illustrated, describing their complete line of gasoline, Diesel, electric and steam-operated cranes, shovels and draglines.

This book gives detailed specifications of their machines with capacities from ¾ yard to 2 yards. Outstanding features and construction details of these machines are described.

Among illustrations are shown crawler cranes handling steel work with hook block; handling sand and gravel with a clam-shell bucket; and handling scrap with a magnet. Locomotive cranes are shown unloading sand, handling coal and other materials.

Crawler shovels are shown in action under severe conditions. Link-Belt machines equipped with dragline, trench hoe and backfiller illustrate the multitude of uses for these machines.

This book, No. 1095, will be sent gratis on request.

New Sullivan Light Drill Steel Sharpener

The Sullivan Machinery Company has published a new bulletin on its light model drill steel sharpener, class "C." This bulletin, No. 72-N, is 16 pages, fully illustrated with details of the sharpener, and with pictures of the machine at work under many different conditions. This sharpener has proved its desirability for work on hammer drill bits and shanks for the lighter drills, utilizing ⅞-in. to 1-in. steel. It is also effective for making pick and chisel point bits for concrete breakers, and other similar tools. The "C" sharpener weighs only 1,100 lbs., placing it in the portable class for the contractor.

The machine requires only a small amount of air, since air is used only while the hammers are reciprocating. The leverage of the clamp which holds the drill steel in position is so arranged that a small amount of air exerts a maximum clamping pressure. As in all Sullivan sharpeners, the "all-hammer" principle of upsetting and swaging the steel is employed, thus retaining the original quality of the steel and increasing its toughness and resistance to wear. The use of an oil or gas drill steel furnace is recommended with this sharpener, as it enables the gradual heating of the drill steel for forging of tempering to the moderate temperature (1,500 to 1,750 degrees) required with this sharpener, and provides opportunity for appropriate control to avoid ruining the steel by burning.

Copies of this new bulletin will be sent upon request to the Sullivan Machinery Company, 400 North Michigan Avenue, Chicago, Ill.

New Switch Throws Motors Across the Line

A new magnetic switch, the CR-7006-D-30, is announced by the General Electric Company to supersede the CR-7006-D-4, and is designed primarily for throwing small motors directly across the line. It can, however, be used as a primary switch for slipring motors having secondary control. It is recommended for use with small motors wherever a simple, direct control, providing complete protection to motor and operator, is required.

The new switch incorporates all modern design principles from the standpoints of size, mechanical construction, appearance, electric ratings, etc. The enclosing case is of the drawn-shell type in which plenty of room is provided for wiring. The reset button for the overload relays extends through a hole through the cover, allowing its use without removing the cover.

Changes from the older D-4 form include the use of a moulded shaft which will not stick in the bearings, thermal overload relays with interchangeable heater units silver contacts on the holding interlock an E frame magnet which requires a minimum of power to operate it, and restricted type blowouts.

B. E. Schonthal & Co., Inc., of Chicago, Ill., have moved their office to suite 844, Railway Exchange Bldg., 224 S. Michigan Avenue, Chicago. They are sales agents for Carroll Chain Co., Conveyor Sales Co., West Virginia Rail Co., Watt Car and Wheel Co., Mines Equipment Co., Chicago Automatic Conveyor Co.

General Electric Pensions

More than a half-million dollars was paid in pensions by the General Electric Company during 1928, the majority of the $514,495 going to pensioners from the various apparatus works. Since the inception of the pension plan in 1912 a total of $2,129,471 has been paid through 1928.

On January 1, 1928, there were 607 pensioners, and at the end of the year there were 877. The average age of those receiving pensions is 68.72 years; the average active service is 28.35 years; and the average annual pension $730.

Subway Excavation by Tunneling Methods *

Route 107, Section 12, of the New York subway, lies 87 ft. below the surface of Newtown Creek. All in all, the job consists of 7,800 lineal ft. of tunnel, 18 ft. in diameter, through solid rock.

This section of the subway construction work has been let to the MidEastern Contracting Corp., New York City. Approximately 6,000 ft. of the total 7,800 have been completed and the balance of the work progressing at top speed.

The time made in this particular type of tunneling has been due to their use of modern equipment. Borrowing from the experience of some of the larger lead mines of the middle southwest, the Mid-Eastern Contracting Corporation purchased a Thew Type S electric mining shovel about 15 months ago.

This particular shovel has low and small clearances, having been designed for the very restricted quarters in underground mines. It is crawler mounted, and equipped with a ½-yd. dipper of special design. Three electric motors are provided for hoisting and lowering; for crowding and retracting or traveling; for swinging in a complete circle. Automatic electric limit switches are provided on all operations to insure safety. Within the limits of this 18 ft. tunnel the Type S can be easily maneuvered for traveling and can make a full circle swing.

Although the machine weighs only approximately 13 tons, it has a crowding force of approximately 12 tons, so that it ate its way through the tough rock excavation so successfully that about 10 months ago the MidEastern Contracting Corp. installed a second unit and 2 months later a third, all of which are operating on Section 12 at the present time. The rock is Fordham Gneiss and is being loaded into 2½-yd. battleship cars running on narrow gauge track. These machines are each averaging between 60 and 70 such loads per 8-hour shift, working 24 hours a day each.

The cars are pulled by a 6-ton Whitcomb storage battery locomotive to vertical shafts where they are hoisted to the surface and dumped into scows.

This method of tunnel excavation on the New York subway is in direct contrast with the open cut methods being used on other sections and requires very different methods and equipment. The MidEastern Contracting Corp. give a great deal of the credit for the speed with which they have handled this job to the successful adaption of Thew Type S mining shovels to general underground tunneling.

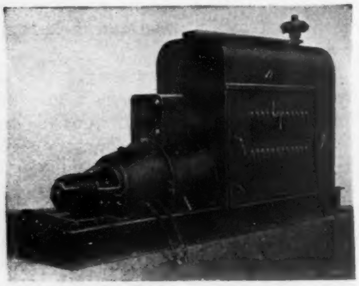
* As related by James E. Gibbons, the Mid-Eastern Contracting Corp., New York City.

Loading rock in a New York subway project with the Thew type S. electric mining shovel

New Gas Engine Driven Arc Welding Set

The Westinghouse Electric and Manufacturing Company announces as new equipment a 300 ampere, gas engine driven, single operator arc welding set. Gas engine driven welding sets are used extensively for supplying welding current where a local power supply is not available as in the case of pipe line and storage tank construction, steam railroad construction and maintenance work, structural steel work, and general construction and repair jobs in isolated places.

The complete set consists of a model P-35 Continental 4 cylinder gas engine direct connected to a new type Westing-



house 300 ampere, single operator, type SK, arc welding generator, with flexibly coupled exciter overhung from generator bracket. The generator has a special bracket which fits into the engine housing, so as to make the complete equipment as compact as possible. The generator control panel is mounted on top of the generator frame and fully enclosed by a sheet metal cabinet. The welding current is varied over the entire range by means of a single dial rheostat. Protective covers over generator commutator and engine hood make the complete equipment suitable for service in all weather conditions without the use of a canopy. The set can be made portable by the addition of running gear parts.

Another feature of this new set is that it is separately excited resulting in simplified control and efficient operation the exciter being flexibly coupled to the welding generator and overhung from the front of the generator bracket.

The Continental Red Seal engine has the S. A. E. rating of 28.9 hp. Under average operating conditions, the fuel consumption is approximately 1½ gals. per hour, the gasoline tank holding 28 gals. For lubrication the pressure feed system with a gear type pump is used.

The Horne Copper Corporation, Noranda, Canada, have recently received 6 Nolan feeders, making 15 feeders and 4 sets of cage locks installed in the last 2 years. They were purchased from the Mining Safety Device Company, Bowerston, Ohio.

Ohio Brass Opens Dallas Office

Ohio Brass Company, Mansfield, Ohio, announces the opening of its new office at 505 Insurance Building, Dallas, Tex. This office will be the headquarters of T. B. Jones, district sales manager for the company in the Dallas territory.

I-C Orders Oil Electric Locomotives

The Illinois Central Railroad Company have ordered five 600 hp. oil electric locomotives from Ingersoll-Rand Company and General Electric Company.

New Westinghouse Publications

Leaflet 20403 is a new publication of the Westinghouse Electric and Manufacturing Company describing the class 11-210 reversing linestarters for squirrel-cage induction motors. These are the across-the-line type linestarters with thermal relay overload protection. The application, construction and distinctive features with illustrations of these details and of the unit as a whole are well presented in this publication.

Folder 5179 presents the many features of Westinghouse steel panels for switchboards. Photographs and diagrams point out the important advantages of steel panels over other kinds.

Folder No. 5188 entitled "D-C Totally Enclosed Fan-Cooled Type SK Motor." Illustrations and a general description explain the construction, the protective devices and the interior cooling system of the motor. The unit applies to such locations where dust, fumes, and abrasive material are present.

Class 11-400 magnetic resistance type starter is described in leaflet, No. 20406. This starter is used where high starting current is not permissible and where voltage regulation is required in bringing a motor up to speed without disconnecting from the line. The operation and construction of this starter are completely described, and the distinctive features among which being the new "Deion" contractor, are pointed out.

Leaflet No. 20421 entitled "Multiple Operator Arc Welding Equipment," presents the application, distinctive features and general principles of construction of different types of stationary and portable multiple operator arc welding sets. Several installation views are shown in the illustrations.

"Type QS Engine-Driven D-C Generators" is the subject of Leaflet No. 20414, describing the application, features, and construction of the type QS generators developed to meet the requirements of steam and internal combustion engine drives. The construction of the generators, which are available from 25 to 1,500 kw. at usual voltages, 2 or 3 wire, from 100 to 450 rpm. is shown by means of numerous illustrations in the leaflet.

A new catalog of first aid and mine safety materials, just issued by the Mine Safety Appliances Company, of Pittsburgh, Pa. Copies may be obatined from the company

New Pyrometer Outfit

The Roller-Smith Company, 233 Broadway, New York City, announces their new Type FD Pyrometer.

The FD Pyrometer outfit consists of a pyrometer, 4 in. in diameter, a thermocouple and leads. The specific application of the device is the indication of the temperature of molten type metal as used with various kinds of type casting machines.

As compared with glass tube thermometers there are many points of superiority. A few are as follows:

Readings can be taken from any position and from considerable distances; there is no breakage and the FD Pyrometer is strong, sturdy and, with reasonable care, will give good results over long periods. Not damaged by abnormal temperatures. The range is from zero to 1200° F.

World's Resources, Production and Commerce In Mineral Raw Materials

The Department of Commerce has issued a report on the world's resources, production and commerce in mineral raw materials. Each country is treated separately to indicate its requirements for each of the minerals and its ability to supply these from within its borders. The report gives a summary of the country's resources and a statistical analysis of production, imports, and exports from 1923 to 1927. Each mineral is considered separately in its relation to the general world position of the various minerals and the position occupied by each of the countries. Major sources of minerals outside of the eight countries considered are indicated. "The inter-dependence of nations for their supplies of mineral raw materials is one of the most significant features of present-day world economy," says the report. "Some nations have more than their share of certain minerals; some conspicuously lack resources, and none has a well-balanced supply of all minerals."

BUYER'S DIRECTORY

ACETYLENE, Dissolved (Or in Cylinders)
Prest-O-Lite Co., Inc.

ACETYLENE GAS
Prest-O-Lite Co., Inc.

ACETYLENE GENERATING APPARATUS
Oxweld Acetylene Co.

ACID, SULPHURIC
Irvington Smelt. & Ref. Works.

AERIAL TRAMWAYS
American Steel & Wire Co.

AFTERCOOLERS (Air)
Ingersoll-Rand Co.

AIR COMPRESSORS
Allis-Chalmers Mfg. Co.
Sullivan Machinery Co.
Ingersoll-Rand Co.

AIR COMPRESSOR OILS
Standard Oil Co. (Ind.)

AIR FILTERS—Bag type
American Coal Cleaning Corpn.

AIR HEATERS
Westinghouse Electric & Mfg. Co.

AIR LIFT PUMPING
Sullivan Machinery Co.

ALL SERVICE GAS MASKS
Mine Safety Appliances Co.

ANEMOMETERS
Mine Safety Appliances Co.

ANNUNCIATOR WIRES & CABLES
Roebling's Sons Co., J. A.

ANNUNCIATOR WIRES & CABLES, INSULATED
American Steel & Wire Co.

ANTI-RUST OILS & GREASES
Standard Oil Co. (Ind.)

ARMATURE COILS & LEADS
General Electric Co.
Roebling's Sons Co., J. A.
Westinghouse Electric & Mfg. Co.

ARMORGRIDS
General Electric Co.

ASPIRATORS
American Coal Cleaning Corpn.

AUTOMATIC CAR & CAGER STOPS
Link-Belt Co.
Mining Safety Device Co.

AUTOMATIC CAR CAGES
Connellsville Mfg. & Mine Supply Co.
Link-Belt Co.
Roberts & Schaefer Co.

AUTOMATIC CAR DUMPERS
Link-Belt Co.
Roberts & Schaefer Co.

AUTOMATIC FLAGGING SIGNALS
American Mine Door Co.

AUTOMATIC (Mine Doors, Trucks and Electric Switches)
American Mine Door Co.

AUTOMATIC MINE SWITCHES
Westinghouse Electric & Mfg. Co.

AUTOMATIC SWITCH THROWERS
American Mine Door Co.
Westinghouse Electric & Mfg. Co.

AUTOMOBILE CABLES
Roebling's Sons Co., J. A.

AUTOMOTIVE LUBRICANTS
Keystone Lubricating Co.

BAG TYPE AIR FILTERS
American Coal Cleaning Corpn.

BALLAST UNLOADER ROPES
Roebling's Sons Co., J. A.

BARS, STEEL
Carnegie Steel Co.
Timken Roller Bearing Co.

BATTERIES
E. I. du Pont de Nemours & Co.

BATTERIES, Armature
Westinghouse Electric & Mfg. Co.

BATTERIES, Blasting
Hercules Powder Co.

BATTERIES, DRY (for Bells, Buzzers, Signals, Blasting)
National Carbon Co., Inc.

BATTERIES (Storage, Gas Welding, Cutting, Dissolved Acetylene)
Prest-O-Lite Co.
Westinghouse Electric & Mfg. Co.

BATTERY CHANGING STATION
Atlas Car & Mfg. Co.

BEARINGS (for all kinds of equipment)
Hyatt Roller Bearing Co.

BEARINGS, RADIAL
Timken Roller Bearing Co.

BEARINGS, TAPERED ROLLER
Timken Roller Bearing Co.

BEARINGS, THRUST
Timken Roller Bearing Co.

BELL CORD
Roebling's Sons Co., J. A.

BELT DRESSING
Standard Oil Co. (Ind.)

BELTING (Conveyor, Elevator, Transmission)
The Jeffrey Mfg. Co.
Link-Belt Co.

BELTING, SILENT CHAIN
Link-Belt Co.
Morse Chain Co.

BINS (Coke and Coal)
The Jeffrey Mfg. Co.
Link-Belt Co.

BIT BOXES
Mine Safety Appliances Co.

BITS, Carbon (Diamonds) for Core Drill
R. S. Patrick.
Diamond Drill Carbon Co.

BITS, Diamond Drilling
R. S. Patrick.

BIT SHARPENERS
Sullivan Machinery Co.
Ingersoll-Rand Co.

BLACK DIAMONDS
Diamond Drill Carbon Co.
R. S. Patrick.

BLACK OILS
Standard Oil Co. (Ind.)

BLASTING ACCESSORIES
E. I. du Pont de Nemours & Co.

BLASTING CAPS
E. I. du Pont de Nemours & Co.
Hercules Powder Co.

BLASTING MACHINES
E. I. du Pont de Nemours & Co.
Hercules Powder Co.

BLASTING POWDER
E. I. du Pont de Nemours & Co.
Hercules Powder Co.

BLASTING SUPPLIES
Hercules Powder Co.

BLASTING UNITS (Dry Battery)
National Carbon Co., Inc.

BLOWERS, CENTRIFUGAL
American Coal Cleaning Corpn.
General Electric Co.
Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Robinson Ventilating Co.
Westinghouse Electric & Mfg. Co.

BLOWERS (or Compressors)
General Electric Co.

BLOWERS (Tubing)
The Jeffrey Mfg. Co.
Robinson Ventilating Co.

BLOWERS (Turbine)
Robinson Ventilating Co.
Westinghouse Electric & Mfg. Co.

BLOWPIPES, Brazing, Carbon Burning, Cutting, Lead Burning Welding, Welding and Cutting
Oxweld Acetylene Co.

BLUE CENTER STEEL WIRE ROPE
Roebling's Sons Co., J. A.
Phillips Mine & Mill Supply Co.

BOND TERMINALS
American Mine Door Co.

BORTZ
R. S. Patrick.
Diamond Drill Carbon Co.

BRACES, GAUGE
Central Frog & Switch Co.

BRACES, RAIL
Central Frog & Switch Co.

BRACES, TRACK
Central Frog & Switch Co.

BRAZILIAN ROCK CRYSTAL
Diamond Drill Carbon Co.

BREAKER MACHINERY
Koppers-Rheolaveur Co.
Vulcan Iron Works.

BREAKERS
American Coal Cleaning Corpn.

BREAKERS (Construction and Machinery)
The Jeffrey Mfg. Co.

BREAST MACHINES
Goodman Mfg. Co.

BRIQUETTING MACHINERY
Vulcan Iron Works.

BRUSHES (Carbon, Graphite and Metal Graphite for Electric Motors, Generators and Converters)
National Carbon Co., Inc.
Westinghouse Electric & Mfg. Co.

BUCKETS (Elevator)
Atlas Car & Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.

BURRELL, GAS INDICATORS, GAS MASKS, MINE AIR ANALYZER
Mine Safety Appliances Co.

CABLE COMPOUNDS
Standard Oil Co. (Ind.)

CABLE—DRILLING, WIRE
American Cable Co.

CABLE—ELEVATOR, MACHINE, ETC. (STEEL)
American Cable Co.

CABLE GREASE
Keystone Lubricating Co.

CABLE—HOISTING
American Cable Co.

CABLE — MINING (HAULAGE, SHAFT HOIST, MINING MACHINE, SLUSHER)
American Cable Co.

CABLES
American Steel & Wire Co.
Roebling's Sons Co., J. A.

CABLES (Connectors and Guides)
American Mine Door Co.

CABLES, INSULATED
General Electric Co.
Roebling's Sons Co., J. A.

CABLES, SUSPENSION BRIDGE
American Cable Co.
Roebling's Sons Co., J. A.

CABLEWAYS
American Steel & Wire Co.
The Jeffrey Mfg. Co.
Link-Belt Co.

CABLE—WIRE
American Cable Co.

CAGE DUMPERS, ROTARY
Link-Belt Co.
Roberts & Schaefer Co.

CAGES (Safety Appliances)
Connellsville Mfg. & Mine Supply Co.

CAGE STOPS & LOCKS
Link-Belt Co.
Mining Safety Device Co.
Roberts & Schaefer Co.

CAGERS, AUTOMATIC
Link-Belt Co.
Mining Safety Device Co.
Phillips Mine & Mill Supply Co.
Roberts & Schaefer Co.

CAGERS, AUTOMATIC & MANUAL
Link-Belt Co.
Mining Safety Device Co.
Roberts & Schaefer Co.

CAGES
Allis-Chalmers Mfg. Co.
C. S. Card Iron Works Co.
Connellsville Mfg. & Mine Sup. Co.
Link-Belt Co.
Vulcan Iron Works.

CAGES (Self-dumping)
Link-Belt Co.
Roberts & Schaefer Co.
Vulcan Iron Works.

CALCINERS
Vulcan Iron Works.

CALCIUM CARBIDE
Union Carbide Sales Co.

CARBON AND BORTZ
Diamond Drill Carbon Co.
R. S. Patrick.

CARBON FOR DIAMOND DRILLING
Diamond Drill Carbon Co.
R. S. Patrick.
Sullivan Machinery Co.

CARBON BURNING APPARATUS
Oxweld Acetylene Co.

CARBON ELECTRODES (for Electric Furnaces and Electrolytic Work)
National Carbon Co., Inc.
Westinghouse Electric & Mfg. Co.

CARBON MONOXIDE DETECTOR
Mine Safety Appliances Co.

CARBONS (for Arc Lamps, Blue Printing, Photographic)
National Carbon Co., Inc.

CARBON RODS AND PASTE FOR WELDING
Oxweld Acetylene Co.
National Carbon Co., Inc.

CARBON SPECIALTIES (Circuit Breaker Contacts, Packing Rings, Filter Plates, Tubes, etc.)
National Carbon Co., Inc.

CAR DUMPERS, GRAVITY & POWER
Link-Belt Co.
Mining Safety Device Co.
Phillips Mine & Mill Supply Co.
Roberts & Schaefer Co.

CAR DUMPERS (Rotary)
Connellsville Mfg. & Mine Supply Co.
Link-Belt Co.
Mining Safety Device Co.
Phillips Mine & Mill Supply Co.
Roberts & Schaefer Co.

CAR FEEDERS
Link-Belt Co.
Mining Safety Device Co.
Roberts & Schaefer Co.

CAR HAULS
Goodman Mfg. Co.
Hockensmith Wheel & Mine Car Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Roberts & Schaefer Co.

CAR PULLERS
Allis-Chalmers Mfg. Co.
Link-Belt Co.
Roberts & Schaefer Co.

CAR REPLACERS
Johnson Wrecking Frog Co.

CAR RERAILERS
Johnson Wrecking Frog Co.

CAR RETARDERS
Link-Belt Co.
Mining Safety Device Co.
Roberts & Schaefer Co.

CARS OF ALL DESCRIPTION
Hockensmith Wheel & Mine Car Co

CAR STOPS, AUTOMATIC & MANUAL
Link-Belt Co.
Phillips Mine & Mill Supply Co.
Roberts & Schaefer Co.

CAR WHEEL LUBRICANTS
Keystone Lubricating Co.

CAR WIRE & CABLES
American Steel & Wire Co.
John A. Roebling's Sons Co.

CASTINGS
Goodman Mfg. Co.
Link-Belt Co.
The Jeffrey Mfg. Co.
Timken Roller Bearing Co.

CASTINGS, GRAY IRON
Link-Belt Co.
Vulcan Iron Works.

CASTINGS, OPEN HEARTH, STEEL
Vulcan Iron Works.

CASTINGS (Steel, Iron)
Vulcan Iron Works.

CAST STEEL FROGS
Central Frog & Switch Co.

CHAINS
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Morse Chain Co.
CHAINS, AUTOMOBILE ENGINE
Link-Belt Co.
Morse Chain Co.
CHAINS, COAL CUTTING
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
CHAINS, DRIVE
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Morse Chain Co.
CHAINS, FRONT END
Link-Belt Co.
Morse Chain Co.
CHAIN LUBRICANTS
Standard Oil Co. (Ind.)
CHAINS, OILING
Morse Chain Co.
CHAINS, POWER TRANSMISSION
The Jeffrey Mfg. Co.
Link-Belt Co.
Morse Chain Co.
CHAINS, Silent (Bushed-Pin Joint)
Link-Belt Co.
CHAINS, SILENT (Rocker-Joint)
Morse Chain Co.
CHAINS, SLING
Link-Belt Co.
Morse Chain Co.
CHAINS, SPROCKET WHEEL
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Morse Chain Co.
CIRCUIT-BREAKERS
Westinghouse Electric & Mfg. Co.
CLAMPS, GUARD RAIL
Central Frog & Switch Co.
CLAMPS (Mine)
Westinghouse Electric & Mfg. Co.
CLAMPS (Trolley)
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.
CLAMPS, WIRE ROPE
American Steel & Wire Co.
Roebling's Sons Co., J. A.
CLIPS, WIRE ROPE
American Cable Co.
American Steel & Wire Co.
Roebling's Sons Co., J. A.
CLOTH, WIRE
Ludlow Saylor Wire Co.
CLUTCHES
Connellsville Mfg. & Mine Supply Co.
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
COAL CLEANING MACHINERY
American Coal Cleaning Corpn.
Koppers-Rheolaveur Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Roberts & Schaefer Co.
COAL COMPANIES
Lehigh Coal & Navigation Co.
COAL CONVEYING MACHINERY
American Coal Cleaning Corpn.
Conveyor Sales Co.
Link-Belt Co.
COAL CRUSHERS
Connellsville Mfg. & Mine Supply Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
COAL CRUSHERS & ROLLS
The Jeffrey Mfg. Co.
Link-Belt Co.
Vulcan Iron Works.
COAL CUTTERS
Goodman Mfg. Co.
Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Sullivan Machinery Co.
COAL HANDLING MACHINERY
American Coal Cleaning Corpn.
Conveyer Sales Co.
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Joy Manufacturing Co.
Link-Belt Co.
Mining Safety Device Co.
Roberts & Schaefer Co.
Westinghouse Electric & Mfg. Co.
COAL LOADERS
Conveyor Sales Co.
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Joy Manufacturing Co.
Link-Belt Co.
Sullivan Machinery Co.

COAL MINING MACHINERY
Goodman Mfg. Co.
Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Sullivan Machinery Co.
Westinghouse Electric & Mfg. Co.
COAL MINING PLANTS
American Coal Cleaning Corpn.
Goodman Mfg. Co.
Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Roberts & Schaefer Co.
COAL PREPARATION MACHINERY
American Coal Cleaning Corpn.
Link-Belt Co.
Roberts & Schaefer Co.
COAL SEPARATING MACHINERY
W. S. Tyler Co.
COAL SEPARATORS (Pneumatic)
American Coal Cleaning Corpn.
Roberts & Schaefer Co.
COAL SEPARATORS (Spiralizers)
Link-Belt Co.
COAL TESTING EQUIPMENT
W. S. Tyler Co.
COMPRESSORS, AIR
Allis-Chalmers Mfg. Co.
Ingersoll-Rand Co.
Sullivan Machinery Co.
COMPRESSORS, MINE CAR
Ingersoll-Rand Co.
Sullivan Machinery Co.
CONCENTRATORS (Table)
Allis-Chalmers Mfg. Co.
CONCRETE REINFORCEMENT
American Steel & Wire Co.
CONDENSERS
Allis-Chalmers Mfg. Co.
Ingersoll-Rand Co.
Westinghouse Electric & Mfg. Co.
CONTROLLERS
General Electric Co.
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.
CONVERTERS, COPPER
Allis-Chalmers Mfg. Co.
Westinghouse Electric & Mfg. Co.
CONVEYORS
American Coal Cleaning Corpn.
Conveyor Sales Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Roberts & Schaefer Co.
CONVEYOR BEARINGS
Link-Belt Co.
CONVEYORS, BELT
American Coal Cleaning Corpn.
The Jeffrey Mfg. Co.
Link-Belt Co.
CONVEYORS, CHAIN FLIGHT
American Coal Cleaning Corpn.
The Jeffrey Mfg. Co.
Link-Belt Co.
CONVEYORS, COAL
American Coal Cleaning Corpn.
Conveyor Sales Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Vulcan Iron Works.
CONVEYORS AND ELEVATORS
Allis-Chalmers Mfg. Co.
American Coal Cleaning Corpn.
The Jeffrey Mfg. Co.
Link-Belt Co.
CONVEYORS, PAN OR APRON
American Coal Cleaning Corpn.
The Jeffrey Mfg. Co.
Link-Belt Co.
CONVEYORS, SCREW
American Coal Cleaning Corpn.
The Jeffrey Mfg. Co.
Link-Belt Co.
COOLERS (Man)
Robinson Ventilating Co.
COOLERS, ROTARY
Vulcan Iron Works.
COPPER WIRE & STRAND (Bare)
American Steel & Wire Co.
Roebling's Sons Co., J. A.
CORDS—SASH, STEEL WIRE
American Cable Co.
CORE DRILLS, Carbon (Diamonds) for
R. S. Patrick.
CORE DRILLING
Hoffman Bros. Drilling Co.
Pennsylvania Drilling Co.
COUPLINGS, FLEXIBLE
Link-Belt Co.
Westinghouse Electric & Mfg. Co.
CREOSOTE TREATED TIES, TIMBERS, POSTS, PILING, Etc.
Ayer & Lord Tie Co.
CROSSINGS AND CROSSOVERS
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Central Frog & Switch Co.
West Virginia Rail Co.

CROSSOVERS
Central Frog & Switch Co.
CROSS TIES, CREOSOTE TREATED
Ayer & Lord Tie Co.
CRUSHER OILS
Standard Oil Co. (Ind.)
CRUSHERS
Allis-Chalmers Mfg. Co.
The Jeffrey Mfg. Co.
CRUSHERS (Coal)
Connellsville Mfg. & Mine Supply Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Vulcan Iron Works.
CRUSHERS, SINGLE and DOUBLE ROLL
Allis-Chalmers Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
CRUSHING PLANTS, COKE
The Jeffrey Mfg. Co.
Link-Belt Co.
CRYSTAL (Quartz)
Diamond Drill Carbon Co.
CUP GREASE
Keystone Lubricating Co.
Standard Oil Co. (Ind.)
CUTTING APPARATUS, Oxy-Acetylene, Oxy-Hydrogen
Oxweld Acetylene Co.
CYCLONE DUST COLLECTORS
American Coal Cleaning Corpn.
DECARBONIZING APPARATUS
Oxweld Acetylene Co.
DESIGNERS OF PLANTS
American Coal Cleaning Corpn.
Koppers-Rheolaveur Co.
Link-Belt Co.
Roberts & Schaefer Co.
DETONATORS
E. I. du Pont de Nemours & Co.
Hercules Powder Co.
DIAMOND CORE DRILL CONTRACTING
Hoffman Bros. Drilling Co.
Sullivan Machinery Co.
DIAMOND DRILLING CARBON
Diamond Drill Carbon Co.
R. S. Patrick.
DIAMONDS, BLACK (See Carbon and Bortz)
Diamond Drill Carbon Co.
R. S. Patrick.
DIAMONDS, INDUSTRIAL
Diamond Drill Carbon Co.
R. S. Patrick.
DIAMOND TOOLS
Diamond Drill Carbon Co.
DIESEL ENGINE OILS
Standard Oil Co. (Ind.)
DIGGERS & PICKS (Pneumatic)
Ingersoll-Rand Co.
DOORS, AUTOMATIC MINE
American Mine Door Co.
DRIFTERS, DRILL
Ingersoll-Rand Co.
Sullivan Machinery Co.
DRILLERS' DIAMONDS
Diamond Drill Carbon Co.
DRILLING CONTRACTORS
Pennsylvania Drilling Co.
Sullivan Machinery Co.
DRILLING, DIAMONDS for
Diamond Drill Carbon Co.
R. S. Patrick.
DRILLS, AIR AND STEAM
Ingersoll-Rand Co.
DRILLS (Blast Hole)
Ingersoll-Rand Co.
DRILL BITS, Carbon (Diamonds) for
Diamond Drill Carbon Co.
R. S. Patrick.
DRILL, CARBON (Diamonds) for
Diamond Drill Carbon Co.
R. S. Patrick.
DRILL COLUMNS & MOUNTINGS
Ingersoll-Rand Co.
Sullivan Machinery Co.
DRILL LUBRICANTS
Standard Oil Co. (Ind.)
DRILLER'S DIAMONDS
R. S. Patrick.
DRILLS, CORE
Hoffman Bros. Drilling Co.
Ingersoll-Rand Co.
DRILLS, ELECTRIC
General Electric Co.
The Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.
DRILLS, HAMMER
Ingersoll-Rand Co.
Sullivan Machinery Co.
DRILLS (Hand Operated Coal)
Ohio Brass Co.

DRILLS, PNEUMATIC
Ingersoll-Rand Co.
DRILLS, PROSPECTING
Hoffman Bros. Drilling Co.
Ingersoll-Rand Co.
DRILLS, ROCK
General Electric Co.
Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Sullivan Machinery Co.
DRILL STEEL SHARPENERS
Ingersoll-Rand Co.
Sullivan Machinery Co.
DRIVES, SILENT CHAIN
Link-Belt Co.
Morse Chain Co.
DRUMS (Hoisting, Haulage)
Connellsville Mfg. & Mine Supply Co.
Link-Belt Co.
Vulcan Iron Works.
DRY CLEANING COAL & COKE
American Coal Cleaning Corpn.
Link-Belt Co.
Roberts & Schaefer Co.
DRYERS, ROTARY
Vulcan Iron Works.
DUMP CARS
Atlas Car & Mfg. Co.
Connellsville Mfg. & Mine Supply Co.,
DUMPS (Rotary, Cradle, Crossover & Kickback)
C. S. Card Iron Works Co.
Link-Belt Co.
Mining Safety Device Co.
Phillips Mine & Mill Supply Co.
Roberts & Schaefer Co.
DUST COLLECTING EQUIPMENT
American Coal Cleaning Corpn.
DUST FILTERS
American Coal Cleaning Corpn.
DYNAMITE
E. I. du Pont de Nemours & Co.
Hercules Powder Co.
DYNAMOS
Allis-Chalmers Mfg. Co.
General Electric Co.
Goodman Mfg. Co.
Westinghouse Electric & Mfg. Co.
DYNAMO OILS
Standard Oil Co. (Ind)
ELECTRICAL APPARATUS
Allis-Chalmers Mfg. Co.
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.
ELECTRICAL CABLES & WIRES
American Steel & Wire Co.
General Electric Co.
Roebling's Sons Co., J. A.
ELECTRIC BLASTING CAPS
Hercules Powder Co.
ELECTRIC HOISTING MACHINERY
Allis-Chalmers Mfg. Co.
ELECTRIC LOCOMOTIVES
General Electric Co.
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.
ELECTRIC LOCOMOTIVE CABLES
Roebling's Sons Co., J. A.
Westinghouse Electric & Mfg. Co.
ELECTRIC MINE SUPPLIES
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.
ELECTRIC WIRES AND CABLES
General Electric Co.
American Steel & Wire Co.
ELECTRICAL SUPPLIES
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.
ELECTRICAL WIRES AND CABLES
Roebling's Sons Co., J. A.
ELECTRODES, WELDING
Roebling's Sons Co., J. A.
ELEVATORS
The Jeffrey Mfg. Co.
Link-Belt Co.
ELEVATORS, BUCKET
The Jeffrey Mfg. Co.
Link-Belt Co.
ELEVATOR CABLES & ROPES
Roebling's Sons Co., J. A.
ELEVATOR AND HOIST MOTORS
Westinghouse Electric & Mfg. Co.
ELEVATOR MACHINERY
Atlas Car & Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.

ENGINE OILS
Standard Oil Co. (Ind.)
ENGINES, GAS AND GASOLINE
Allis-Chalmers Mfg. Co.
Ingersoll-Rand Co.
Westinghouse Electric & Mfg. Co.
ENGINES (Hoisting and Hauling)
Connellsville Mfg. & Mine Supply Co.
Westinghouse Electric & Mfg. Co.
ENGINES, OIL
Allis-Chalmers Mfg. Co.
Ingersoll-Rand Co.
ENGINES, STEAM
Allis-Chalmers Mfg. Co.
Ingersoll-Rand Co.
EXCAVATORS
Link-Belt Co.
EXHAUSTERS
American Coal Cleaning Corpn.
EXPLOSIVES
The E. I. du Pont Powder Co.
Hercules Powder Co.
FAN DRIVES
Link-Belt Co.
Vulcan Iron Works.
Westinghouse Electric & Mfg. Co.
FANS, Man Cooling
Robinson Ventilating Co.
Westinghouse Electric & Mfg. Co.
FANS, Turbine
Robinson Ventilating Co.
Westinghouse Electric & Mfg. Co.
FANS, VENTILATING
Connellsville Mfg. & Mine Supply Co.
The Jeffrey Mfg. Co.
Robinson Ventilating Co.
Vulcan Iron Works.
Westinghouse Electric & Mfg. Co.
FEEDERS
Hockensmith Wheel & Mine Car Co.
FEEDERS (Crossover, Kickback, Rotary and Dump)
Link-Belt Co.
Mining Safety Device Co.
Phillips Mine & Mill Supply Co.
Roberts & Schaefer Co.
FEEDERS (Gravity)
American Coal Cleaning Corpn.
Link-Belt Co.
FEEDERS (Hand Operated)
Link-Belt Co.
Mining Safety Device Co.
Roberts & Schaefer Co.
FEEDERS, ORE
The Jeffrey Mfg. Co.
Link-Belt Co.
FEEDERS (Reciprocating)
Link-Belt Co.
American Coal Cleaning Corpn.
FEEDERS (Semi-automatic)
Link-Belt Co.
Mining Safety Device Co.
Phillips Mine & Mill Supply Co.
FIBRE GREASES
Standard Oil Co. (Ind.)
FILTER CLOTH, WIRE
Ludlow Saylor Wire Co.
FILTERS (Dust)
American Coal Cleaning Corpn.
FIRE AND WEATHER-PROOF WIRE
Roebling's Sons Co., J. A.
FIRST AID SUPPLIES
Mine Safety Appliances Co.
FITTINGS—WIRE ROPE (Tru-Loc Brand Processed)
American Cable Co.
FITTINGS—WIRE ROPE (Thimbles, Clips, Sockets, Hooks, Shackles Turnbuckles)
American Cable Co.
FLASHLIGHTS AND BATTERIES (Mine Safety)
National Carbon Co., Inc.
FLOTATION MACHINES
Allis-Chalmers Mfg. Co.
FLOTATION OILS
Hercules Powder Co.
FLOW METERS
General Electric Co.
FLUX, WELDING
Oxweld Acetylene Co.
FORGINGS
Allis-Chalmers Mfg. Co.
FROGS
Central Frog & Switch Co.
FROGS AND SWITCHES
C. S. Card Iron Works Co.
Central Frog & Switch Co.
West Virginia Rail Co.
FURNACE OIL
Standard Oil Co. (Ind.)
FURNACES, Oil (for drill steel)
Ingersoll-Rand Co.
FURNACES, ROASTING
Allis-Chalmers Mfg. Co.
Westinghouse Electric & Mfg. Co.
GAS (Cutting, Welding)
Prest-O-Lite Co., Inc.
GAS (Nitrogen, Oxygen)
Linde Air Products Co.
GASOLINE
Standard Oil Co. (Ind.)
GAS ENGINE OILS
Standard Oil Co. (Ind.)
GAS MASKS
Mine Safety Appliances Co.
GAUGES, WELDING & CUTTING
Central Frog & Switch Co.
GAUGE RODS
Central Frog & Switch Co.
GAUGES, WELDING & CUTTING
Oxweld Acetylene Co.
GEAR COMPOUNDS
Standard Oil Co. (Ind.)
GEARS
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
GEARS, BEVEL
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
GEARS (Fabroil & Textolite)
General Electric Co.
GEARS, HERRINGBONE
Link-Belt Co.
Vulcan Iron Works.
GEARS, Machine Cut
Link-Belt Co.
Vulcan Iron Works.
GEARS, Moulded Tooth
Link-Belt Co.
Vulcan Iron Works.
GEARS, Silent Chain
Link-Belt Co.
Morse Chain Co.
GEARS, SPUR
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Vulcan Iron Works.
GEARS, WORM
The Jeffrey Mfg. Co.
GELATIN DYNAMITES
E. I. Du Pont de Nemours & Co.
Hercules Powder Co.
GENERATORS AND GENERATING SETS
Allis-Chalmers Mfg. Co.
General Electric Co.
Goodman Mfg. Co.
Westinghouse Electric & Mfg. Co
GENERATORS, ACETYLENE
Oxweld Acetylene Co.
GLOVES, ASBESTOS
Oxweld Acetylene Co.
GOGGLES, MINERS' WIRE SCREEN, NOD AND SHAKE WELLSWORTH
Mine Safety Appliances Co.
GOGGLES, WELDING
Oxweld Acetylene Co.
GRAPHITE GREASES
Standard Oil Co. (Ind.)
GREASE
Keystone Lubricating Co.
Standard Oil Co. (Ind.)
GREASE CUPS
Keystone Lubricating Co.
GRINDERS, Portable Pneumatic
Ingersoll—Rand Co.
GUARD RAIL CLAMPS
Central Frog & Switch Co.
GUY ROPES, GALVANIZED
American Steel & Wire Co.
Roebling's Sons Co., J. A.
HAMMERS, Calking, Chipping & Riveting
Ingersoll-Rand Co.
HANGERS
Link-Belt Co.
HANGERS (Insulated Trolley)
Ohio Brass Co.
HANGERS, SHAFT, DROP
Link-Belt Co.
HANGERS, SHAFT, POST
Link-Belt Co.
HANGERS, SHAFT, SELF-OILING
Link-Belt Co.
HAULAGE ROPE
American Steel & Wire Co.
Roebling's Sons Co., J. A.
HEADLIGHTS, ARC AND INCANDESCENT
General Electric Co.
Goodman Mfg. Co
The Jeffrey Mfg. Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.
HEATER CORD
Roebling's Sons Co., J. A.
HERRINGBONE GEAR DRIVES
Link-Belt Co.
H-H INHALATORS
Mine Safety Appliances Co.
HIGH EXPLOSIVES
E. I. Du Pont de Nemours & Co.
Hercules Powder Co.
HOIST DRIVES
Link-Belt Co.
Vulcan Iron Works.
HOISTING ROPES
American Steel & Wire Co.
Connellsville Mfg. & Mine Supply Co.
Roebling's Sons Co., J. A.
HOISTS
American Steel & Wire Co.
Ingersoll-Rand Co.
Link-Belt Co.
Sullivan Machinery Co.
HOISTS, AIR
Ingersoll-Rand Co.
Sullivan Machinery Co.
HOISTS, ELECTRIC
Allis-Chalmers Mfg. Co.
Connellsville Mfg. & Mine Supply Co.
General Electric Co.
Goodman Mfg. Co.
Sullivan Machinery Co.
Vulcan Iron Works
HOISTS, PORTABLE
Ingersoll-Rand Co.
Sullivan Machinery Co.
HOISTS, Room
Vulcan Iron Works.
HOISTS, Room and Gathering
Goodman Mfg. Co.
HOISTS, Scraper-Loader
Connellsville Mfg. & Mine Supply Co.
Ingersoll-Rand Co.
Sullivan Machinery Co.
HOISTS, STEAM
Allis-Chalmers Mfg. Co.
Connellsville Mfg. & Mine Supply Co.
Ingersoll-Rand Co.
Vulcan Iron Works.
HOLDERS-ON RIVETING
Ingersoll-Rand Co.
HOOKS
Roebling's Sons Co., J. A.
HOOKS, WIRE ROPE
American Cable Co.
HOSE, AIR AND STEAM
Ingersoll-Rand Co.
HOSE, WELDING AND CUTTING
Oxweld Acetylene Co.
HYDRATORS, LIME
Vulcan Iron Works.
IGNITERS, Electric
Hercules Powder Co.
INCINERATORS
Vulcan Iron Works.
INCLINE FROGS
Central Frog & Switch Co.
INCLINE TRACK LAYOUTS
Central Frog & Switch Co.
INSULATORS, FEEDER WIRE
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.
INSULATORS, SECTION
American Mine Door Co.
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.
INSULATORS (Porcelain)
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.
INSULATORS (Third Rail)
General Electric Co.
Ohio Brass Co.
INSULATORS (Trolley)
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.
INSULATED WIRE AND CABLE
American Steel & Wire Co.
General Electric Co.
Roebling's Sons Co., J. A.
KEROSENE
Standard Oil Co. (Ind.)
KEYSTONE GREASE
Keystone Lubricating Co.
KEYSTONE GREASE CUPS
Keystone Lubricating Co.
KEYSTONE SAFETY LUBRICATORS
Keystone Lubricating Co.
KILNS (Rotary)
Allis-Chalmers Mfg. Co.
Vulcan Iron Works.
KILNS, VERTICAL
Vulcan Iron Works.
LAMP CORD
American Steel & Wire Co.
Roebling's Sons Co., J. A.
LAMPS, ARC AND INCANDESCENT
General Electric Co.
Westinghouse Electric & Mfg. Co.
LAMPS (Edison Electric)
Mine Safety Appliances Co.
LEAD BURNING APPARATUS, Oxy-Acetylene, Oxy-City Gas
Oxweld Acetylene Co.
LIGHT AND POWER PLANTS (Small)
Westinghouse Electric & Mfg. Co.
LIGHT STEEL ANGLES
Carnegie Steel Co.
LIGHT STEEL RAILS
Carnegie Steel Co.
West Virginia Rail Co.
LOADERS, Gravel and Sand
Joy Manufacturing Co.
Link-Belt Co.
LOADERS (Mine Car)
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Joy Manufacturing Co.
Link-Belt Co.
Myers-Whaley Co.
LOADERS, PORTABLE
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Joy Manufacturing Co.
Link-Belt Co.
Myers-Whaley Co.
LOADERS, Snow
Joy Manufacturing Co.
LOADERS, Truck
Joy Manufacturing Co.
Link-Belt Co.
LOADERS, Wagon
Joy Manufacturing Co.
Link-Belt Co.
LOADING BOOMS
Connellsville Mfg. & Mine Supply Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Roberts & Schaefer Co.
LOADING MACHINES
Connellsville Mfg. & Mine Supply Co.
Conveyor Sales Co.
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Myers-Whaley Co.
LOCOMOTIVES, ELECTRIC
General Electric Co.
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.
LOCOMOTIVES, GASOLINE
Vulcan Iron Works.
Westinghouse Electric & Mfg. Co.
LOCOMOTIVES, RACK RAIL
Atlas Car & Mfg. Co.
Goodman Mfg. Co.
LOCOMOTIVES, STEAM
Vulcan Iron Works.
LOCOMOTIVES, STORAGE BATTERY
Atlas Car & Mfg. Co.
General Electric Co.
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Vulcan Iron Works.
Westinghouse Electric & Mfg. Co.
LOCOMOTIVE SWITCHING & WRECKING ROPES
Roebling's Sons Co., J. A.
LOCOMOTIVES (Third Rail)
Atlas Car & Mfg. Co.
Goodman Mfg. Co.
LOCOMOTIVES, TROLLEY
Atlas Car & Mfg. Co.
General Electric Co.
Goodman Mfg. Co.
Vulcan Iron Works.
Westinghouse Electric & Mfg. Co.
LONGWALL MACHINES
Goodman Mfg. Co.
Sullivan Machinery Co.
LUBRICANTS
Keystone Lubricating Co.
Standard Oil Co. (Ind.)
LUBRICATING DEVICES
Keystone Lubricating Co.
LUBRICATING GREASES
Keystone Lubricating Co.
LUBRICATING ENGINEERS
Keystone Lubricating Co.

LUBRICATORS
Keystone Lubricating Co.
MACHINE OILS
Standard Oil Co. (Ind.)
MACHINERY, TRANSMISSION (Power)
Allis-Chalmers Mfg. Co.
Link-Belt Co.
Morse Chain Co.
MANIFOLDS, OXYGEN
Oxweld Acetylene Co.
MAST ARM ROPE, Galvanized
Roebling's Sons Co., J. A.
METHANE RECORDER, CONTINUOUS
Mine Safety Appliances Co.
MILL GREASES
Standard Oil Co. (Ind.)
MILLS, ROD & BALL
Allis-Chalmers Mfg. Co.
MILLS, STAMPS
Allis-Chalmers Mfg. Co.
MINE CAR AXLES
Hockensmith Wheel & Mine Car Co.
MINE CAR BEARINGS
Hyatt Roller Bearing Co.
Timken Roller Bearing Co.
MINE CAR BOXES
Hockensmith Wheel & Mine Car Co.
MINE CAR FORGINGS
Hockensmith Wheel & Mine Car Co.
MINE CAR LUBRICANTS
Keystone Lubricating Co.
Standard Oil Co. (Ind.)
MINE CAR PARTS
C. S. Card Iron Works Co.
Hockensmith Wheel & Mine Car Co.
Phillips Mine & Mill Supply Co.
MINE CARS
Atlas Car & Mfg. Co.
C. S. Card Iron Works Co.
Enterprise Wheel & Car Corpn.
Hockensmith Wheel & Mine Car Co.
Phillips Mine & Mill Supply Co.
MINE CAR WHEELS
C. S. Card Iron Works Co.
Hockensmith Wheel & Mine Car Co.
MINE DOORS, AUTOMATIC
American Mine Door Co.
MINE LOCOMOTIVE CABLE
American Steel & Wire Co.
General Electric Co.
Roebling's Sons Co., J. A.
MINE TIES
Central Frog & Switch Co.
MINE TIES, CREOSOTE TREATED
Ayer & Lord Tie Co.
MINING & METALLURGICAL MACHINERY
Allis-Chalmers Mfg. Co.
Westinghouse Electric & Mfg. Co.
MINING EQUIPMENT
Allis-Chalmers Mfg. Co.
Goodman Mfg. Co.
Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Westinghouse Electric & Mfg. Co.
MINING MACHINE CABLE
General Electric Co.
Roebling's Sons Co., J. A.
MINING MACHINES
Goodman Mfg. Co.
Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Sullivan Machinery Co.
MINING MACHINES (Electric)
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.
MINING MACHINES (Government Approved)
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
MINING MACHINERY
Goodman Mfg. Co.
Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Westinghouse Electric & Mfg. Co.
MINING MACHINERY BEARINGS
Hyatt Roller Bearing Co.
MINING MACHINERY LUBRICANTS
Keystone Lubricating Co.
MINING MACHINE ROPES
American Cable Co.
MINING POSTS, CREOSOTE TREATED
Ayer & Lord Tie Co.
MINING ROPES (Haulage, Shaft Hoist, Mining Machine, Slusher)
American Cable Co.
MINING TIMBERS, CREOSOTE TREATED
Ayer & Lord Tie Co.
MOTOR OILS
Standard Oil Co. (Ind.)

MOTORS
Allis-Chalmers Mfg. Co.
General Electric Co.
Goodman Mfg. Co.
Westinghouse Electric & Mfg. Co.
MOTORS, Electric
Westinghouse Electric & Mfg. Co.
MOUNTED BOTTOM CUTTERS
Goodman Mfg. Co.
MOVING PICTURE CORD
American Steel & Wire Co.
Roebling's Sons Co., J. A.
NITROGEN GAS
Linde Air Products Co.
OILS
Standard Oil Co. (Ind.)
ORE, BUYERS AND SELLERS OF
Irvington Smelt. & Ref. Works.
OVERCUTTING MACHINES
Goodman Mfg. Co.
Sullivan Machinery Co.
OXYGEN GAS
Linde Air Products Co.
OXYGEN BREATHING APPARATUS, McCAA TWO-HOUR
Mine Safety Appliances Co.
OXY-ACETYLENE APPARATUS and SUPPLIES
Oxweld Acetylene Co.
PAVING BREAKERS
Ingersoll-Rand Co.
Sullivan Machinery Co.
PERFORATED METAL
Allis-Chalmers Mfg. Co.
PERMISSIBLES, Explosives
The E. I. Du Pont Powder Co.
Hercules Powder Co.
PETROLATUMS
Standard Oil Co. (Ind.)
PICKING TABLES
The Jeffrey Mfg. Co.
Link-Belt Co.
Roberts & Schaefer Co.
PIPE (Genuine Wrought Iron)
A. M. Byers Co.
PIPE (Wood)
Connellsville Mfg. & Mine Supply Co.
PNEUMATIC COAL SEPARATING MACHINERY
American Coal Cleaning Corp.
PNEUMATIC SIZING MACHINERY
American Coal Cleaning Corp.
PNEUMATIC TOOL
Ingersoll-Rand Co.
PNEUMATIC TOOL LUBRICANT
Standard Oil Co. (Ind.)
PORTABLE TRACK
Central Frog & Switch Co.
PORTABLE TURNOUTS
Central Frog & Switch Co.
POSTS, CREOSOTE TREATED
Ayer & Lord Tie Co.
POWDER, BLASTING
E. I. Du Pont de Nemours & Co.
Hercules Powder Co.
POWER CABLES
American Steel & Wire Co.
General Electric Co.
Roebling's Sons Co., J. A.
POWER SHOVELS
Link-Belt Co.
POWER TRANSMISSION MACHINERY
Allis-Chalmers Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Morse Chain Co.
Westinghouse Electric & Mfg. Co.
PREHEATING APPARATUS
Oxweld Acetylene Co.
PRESSURE GUN GREASE
Standard Oil Co. (Ind.)
PROSPECTIVE DRILLS
Hoffman Bros. Drilling Co.
Ingersoll-Rand Co.
Pennsylvania Drilling Co.
PULLEYS
Link-Belt Co.
PULLEYS, CLUTCH, FRICTION
Link-Belt Co.
PULVERIZERS, COAL AND COKE
The Jeffrey Mfg. Co.
PUMPS, Acid Resisting
Ingersoll-Rand Co.
PUMPS, AIR LIFT
Ingersoll-Rand Co.
Sullivan Machinery Co.
PUMPS, Boiler Feed
Ingersoll-Rand Co.
Westinghouse Electric & Mfg. Co.
PUMPS, CENTRIFUGAL
Allis-Chalmers Mfg. Co.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works).

PUMPS, DEEP WELL
Ingersoll-Rand Co.
PUMPS (Electric)
Allis-Chalmers Mfg. Co.
Connellsville Mfg. & Mine Supply Co.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works).
Westinghouse Electric & Mfg. Co.
PUMPS, Fire
Ingersoll-Rand Co.
PUMPS (Gathering or Dip)
Connellsville Mfg. & Mine Supply Co.
PUMPS, Inclined Shaft
Ingersoll-Rand Co.
PUMPS, MINE
Allis-Chalmers Mfg. Co.
Connellsville Mfg. & Mine Supply Co.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works).
PUMPS, Sinking
Ingersoll-Rand Co.
PUMPS, PNEUMATIC AIR LIFT
Ingersoll-Rand Co.
PUMPS, POWER
Connellsville Mfg. & Mine Supply Co.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works).
PUMPS, SAND
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works).
PUMPS, STEAM
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works).
PUMPS, VACUUM
Ingersoll-Rand Co.
PUNCHES, Drill Steel
Ingersoll-Rand Co.
Sullivan Machinery Co.
QUARRYING MACHINERY
Ingersoll-Rand Co.
Sullivan Machinery Co.
QUARTZ CRYSTAL
Diamond Drill Carbon Co.
RAIL BONDS
American Steel & Wire Co.
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.
RAIL BRACES
Central Frog & Switch Co.
RAILWAY SUPPLIES
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.
RAILWAY TIES, CREOSOTE TREATED
Ayer & Lord Tie Co.
RAMMERS, Pneumatic
Ingersoll-Rand Co.
RECEIVERS, AIR
Ingersoll-Rand Co.
REGULATORS, Welding and Cutting, Compressed Gas
Oxweld Acetylene Co.
REHEATERS, Air
Ingersoll-Rand Co.
REINFORCING BARS
West Virginia Rail Co.
RESCUE APPARATUS
Link-Belt Co.
Mine Safety Appliances Co.
RETARDERS
Mining Safety Device Co.
Roberts & Schaefer Co.
RIVER CROSSING SUSPENSION WIRE, Galvanized
Roebling's Sons Co., J. A.
ROCK-DISPOSAL EQUIPMENT
Link-Belt Co.
Roberts & Schaefer Co.
ROCK DRILLS
Ingersoll-Rand Co.
ROCK DUSTING EQUIPMENT
American Mine Door Co.
Mine Safety Appliances Co.
RODS, WELDING
Ohio Brass Co.
Oxweld Acetylene Co.
ROLLER BEARINGS
Enterprise Wheel & Car Corporation.
Hyatt Roller Bearing Co.
Timken Roller Bearing Co.
ROLLERS
C. S. Card Iron Works Co.
ROLLS (Crushing)
Allis-Chalmers Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
ROPE
American Steel & Wire Co.
ROPE GREASE
Keystone Lubricating Co.
ROPE, MINING (Haulage, Shaft Hoist, Mining Machine, Slusher)
American Cable Co.

ROPE, SWITCH WIRE
American Cable Co.
ROPE, TOWING WIRE
American Cable Co.
ROPE, TRANSMISSION
American Steel & Wire Co.
Roebling's Sons Co., J. A.
ROPE, WIRE
American Steel & Wire Co.
Roebling's Sons Co., J. A.
ROPE, WIRE (Crescent Brand Ordinary)
American Cable Co.
ROPE, WIRE (Plain or Galvanized)
American Cable Co.
ROPE, WIRE (Tru-Lay Brand Preformed)
American Cable Co.
ROTARY COOLERS
Vulvan Iron Works.
ROTARY DRYERS
Vulcan Iron Works.
ROTARY DUMPS
C. S. Card Iron Works Co.
Link-Belt Co.
Mining Safety Device Co.
Phillips Mine & Mill Supply Co.
Roberts & Schaefer Co.
ROTARY ROASTERS
Vulcan Iron Works.
RUNNING ROPE, Galvanized
American Steel & Wire Co.
Roebling's Sons Co., J. A.
SAFETY APPLIANCES, MINE
Connellsville Mfg. & Mine Supply Co.
SAFETY FUSE
Hercules Powder Co.
SAFETY FUSE & WIRES—LEADING & CONNECTING
E. I. Du Pont de Nemours & Co.
SAFETY LUBRICATORS
Keystone Lubricating Co.
SAND DRYERS
Roberts & Schaefer Co.
SASH CORD
Roebling's Sons Co., J. A.
SAWS (Air)
Ingersoll-Rand Co.
SCRAPER LOADERS
Goodman Mfg. Co.
Sullivan Machinery Co.
SCREEN BARS
Phillips Mine & Mill Supply Co.
SCREENS (Anti-Gravity)
American Coal Cleaning Corpn.
SCREENS, ARCH-CRIMP
Ludlow Saylor Wire Co.
SCREENS, DOUBLE CRIMPED
Ludlow Saylor Wire Co.
SCREENS, HORIZONAL
Link-Belt Co.
Roberts & Schaefer Co.
W. S. Tyler Co.
SCREENS, PERFORATED METAL
Allis-Chalmers Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
SCREENS, REK-TANG
Ludlow Saylor Wire Co.
SCREENS, REVOLVING
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Standard Oil Co. (Ind.)

INDEX TO ADVERTISERS

V
1
5
8

A
U
G

2
9
XU